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CALIFORNIA FISH AND GAME

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Distribution and Variation in Deer (Genus Odocoileus) of the Pacific Coastal Region of North America

By IAN MCTAGGART COWAN

(Contribution from the University of California Museum of Vertebrate Zoology)

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INTRODUCTION

The first deer of western North America to be formally recognized was the mule deer to which Rafinesque in 1817 applied the technical

name *Cervus hemionus*. From that time on, as the exploring parties penetrated the Pacific coastal region, along different latitudes, several other kinds of deer were made known to science. Many of these were regarded as distinct species, and the specimens that have accumulated since then from areas between the earlier routes of exploration have been less carefully studied or not reported upon at all.

It was the aim, therefore, in the present study to examine this additional material and to present in so far as possible a unified picture of the distribution and variation of the North American species of *Odocoileus* west of the Rocky Mountains. In all, 602 specimens have been available. Study of these, supplemented by the work of previous students, gives basis for the recognition in the area mentioned of two full species. One of these, the white-tailed deer *Odocoileus virginianus*, is represented by two geographic races and the other, the black-tailed deer *Odocoileus hemionus*, by nine races. One name commonly used in recent years, *Odocoileus columbianus scaphiotus* Merriam, has been put in synonymy, and two additional races have been recognized and newly named (see Cowan, 1933a, 1933b).

One interesting result of the study was the finding of complete intergradation between *Odocoileus columbianus* and *Odocoileus hemionus* previously regarded as distinct species because of their marked difference in size, coloration and other structural features. Although the two have long been known to interbreed in the captive state (Caton, 1881:312) and Jackson (1921:140) it is only in recent years that accounts of this crossing in nature have appeared. Bryan Williams (1925:178) remarks upon a number of supposed hybrids that he observed in southern British Columbia. Dixon (1934:188) also comments briefly upon the existence of hybrids, which have, indeed, been familiar to many of those working in the field on the deer of California.

The *columbianus* group of races ranges in the humid Pacific coastal strip west of the summit of the Cascade-Sierra Nevada cordillera. The western limit of the *hemionus* group is found at the summit of the same mountain chain. This place, in a general way, marks the dividing line between many pairs of named kinds of smaller mammals, known to intergrade and which, therefore, are regarded as geographic races of single species. With deer, however, there is the added complication of two seasonal migrations. In the autumn the two races of deer named migrate down to the lower country, *columbianus* on the west side and *hemionus* on the east side. Consequently, throughout the greater part of this mountain chain the two do not occupy the same area of range during the breeding season, and opportunity for crossing is accordingly limited.

In certain localities, however, broad valleys or breaks penetrate the mountains transversely, and here, in mild winters at least, the fall migration does not completely separate the two kinds. Thus the rut may find representatives of both races on the same ground, and in these areas extensive interbreeding occurs. Such areas exist in the Pemberton Valley of southern British Columbia and in Shasta, Siskiyou, eastern Tehama, Plumas and extreme eastern Butte counties, California. There is some reason to believe that another such region is comprised in the

upper Bella Coola Valley and the valley of the Hotnarko River in British Columbia.

During a two day stay in the Shasta-Siskiyou area of intergradation, in northern California, 54 deer were seen well enough for me to ascertain that 7 were to all external appearances typical *hemionus,* 2 were apparently typical *columbianus* and the remaining 45 showed signs of mixed parentage. These deer were observed in May, prior to the summer influx of mule deer and coast deer, and are thought to be of the population resident there. The migratory instinct of the Rocky Mountain Mule Deer draws this race eastward in the autumn, while that of the Coast Deer draws its members westward. It is perhaps significant, then, that the hybrid population appears to be largely resident on the area upon which the intergradation has taken place.

More complete intergradation occurs between *hemionus* and *columbianus* by way of *O. h. californicus.* Beginning with *hemionus* to the northward this transition is accomplished along a U-shaped path coursing down along the Sierra Nevada, through the mountains around the southern end of the San Joaquin Valley, and back northward up the Coast Range and coast into *columbianus.* Along this path of intergradation the transition from one race to the next is so complete, comprising as it does gradual change in nearly every important differential feature and involving nearly all the deer in a given region of change, that the term intergradation as opposed to hybridization is unquestionably applicable. Because of this complete intergradation the kinds of deer involved are referred to a single species, and *Odocoileus columbianus* is reduced to subspecific status under the earlier named *Odocoileus hemionus.*

More exact information on the behavior of several visibly appraisable differential features of *hemionus* and *columbianus* was had in October, 1934, when I examined 11 individuals of the first filial generation resulting from the crossing in captivity of a male of the race *O. h. hemionus* with five females of the race *O. h. columbianus.* The hybridization was carried out at Ukiah, California, by Mr. James Montgomery and Mr. R. O. Rompont.

Male parent *O. h. hemionus* from Modoc County, California; female parents *O. h. columbianus* from Mendocino County, California; number of F^1 offspring produced in two years, 17. Eight of these were males and 9 were females. I examined 11 of these offspring as follows: three males, 16 months old; three females, 16 months old; two males, 4 months old; and three females, 4 months old. One of the noteworthy features about this group of hybrids was their uniformity in almost all characters; the one character that was most variable was length of metatarsal gland. Body color of the hybrids appeared to be the same as that of their female parents, but this feature was difficult to appraise in the moving animals, and it is possible that some blending had taken place. All were in the winter pelage when examined. The accompanying table presents the analysis of characters.

It is significant that the male mule deer mated readily with the female coast deer when females of its own race were available. Matings of this male with female *hemionus* resulted in two typical *hemionus* fawns.

Nature of character exhibited by parents and offspring in hemionus-columbianus *cross*

Character	*columbianus*	*hemionus*	*hybrid*
Ear	small size	large size	intermediate
	not woolly	woolly	intermediate
	without black edges	black edges	black edges
Tail	terminal one-half black, base brown	tip black, rest white	all black
	broad at base	narrow at base	intermediate
	haired below	one-half naked below	intermediate
Metatarsal gland	short	long	variable
General body color	brownish	grayish	brownish
Underparts	brownish	blackish	blackish
Rump patch	small	large	intermediate to small
First antlers	generally spike	generally forked	generally forked
Face marking of males	dull	bright	bright
Body size	small	large	large to intermediate

From the above it might seem that a degree of dominance was indicated by the behavior of certain characters in the hybrids. Also, at least some of the characters present in the hybrids are obviously the result of blending of those of the parents. Of these, the intermediate nature of the ear as regards its size, shape and hairiness, and also the size of the metatarsal gland and the rump patch are almost identical with the conditions normally exhibited by *O. h. californicus*, the race which bridges the gap between *columbianus* and *hemionus*. The larger antlers of the captive hybrids may simply result from the operation of a constant relative growth ratio between body size and size of antlers. The intensification of the tail pigmentation in the F^1 hybrids over that of either of the parents is an unexpected condition, but according to Bailey (1931:39) the same thing is shown by hybrids resulting from the crossing of *O. h. hemionus* with *O. v. virginianus*. When *columbianus-hemionus* hybrids are crossed with pure *hemionus* stock, this pigmentation tends to become reduced, so that a hybrid population in a state of nature presents all degrees of coloration of the dorsal face of the tail from entirely black, to white with a thin brown line.

Within the geographically variable species *Odocoileus hemionus* it develops that the insular populations are invariably of smaller size than their nearest relatives on the mainland. Also, on the mainland certain features of structure appear to be closely correlated with environment. The northern races exceed the southern ones in size and show a greater degree of sexual dimorphism. In the inland races from north to south the length and hairiness of the ear show reduction, but in the coastal races the converse is true, except for the hairiness which increases toward the north.

The evolutionary implication of this study of a group of large mammals and its relation to environment is that haphazard mutation

is of little importance *per se* in producing geographic races. The broad parallelism between certain environmental features and certain characters of the deer point to the environment as the most important factor in the evolutionary process. Evolution of the environment seems to be essential for evolution of this mammalian organism. Environment indirectly fosters the persistence of, or possibly directly influences the production of, new characters. These new characters may themselves be adaptive, or they may be nonadaptive but linked to adaptive characters. In either case the characters owe their present existence primarily to environmental influence.

ACKNOWLEDGMENTS

Extensive collecting and research in the northwest coastal region, initiated by, and often conducted in person by, Miss Annie M. Alexander beginning in 1906 have resulted in the accumulation at the California Museum of Vertebrate Zoology of material of special value in the present study. To Dr. Joseph Grinnell and Dr. E. Raymond Hall, of the Museum, I am especially indebted for assistance with the present study.

To Major James A. Farley, Mr. Joseph S. Hunter and Mr. Donald D. McLean of the California Fish and Game Commission, and to Mr. A. Bryan Williams, Chief Game Commissioner of British Columbia, I am indebted for the cordial cooperation of the departments named. To each of these men I am beholden for putting at my disposal information derived from his many years of experience with deer.

I wish to thank the following persons for permission to examine specimens under their charge, or for actual loan of important specimens: Dr. Rudolph M. Anderson, Dr. Hartley H. T. Jackson, Mr. Stanley G. Jewett, Mr. Francis Kermode, Dr. William H. Burt, Mr. Ralph Ellis, Mr. Kenneth Racey and Dr. Merton Y. Williams.

The completeness of the material from California is due in large part to the enthusiatsic cooperation of Mr. Gus Nordquist, the well known taxidermist of Oakland, California, through whose efforts some hundreds of specimens have been made available for examination.

To Mr. Hamilton M. Laing, Mr. James Moffitt, Mr. Fred Johnston, Dr. C. McLean Fraser, Major Allan Brooks and Mr. Thomas T. McCabe I wish to express my deep appreciation of the many and various forms of assistance rendered.

Many discussions held with fellow naturalists, particularly at the Museum of Vertebrate Zoology, have led to clarification of my ideas and have contributed to the final results set forth in this paper. And I recall the assistance given by many other naturalists and hunters without which it would have been impossible to assemble the necessary material. To all those who aided in this way, though their names be too numerous to record here, I, nevertheless, extend by sincere thanks.

VARIATION IN THE GENUS ODOCOILEUS

A systematic study of any group of mammals necessarily involves the study of variation within that group. Distinction of the various lesser taxonomic categories is based almost entirely on differences, and

subspecies entirely so. Indeed, the latter are useful to many principally as aids in dealing with geographic variations. In diagnosing species and especially subspecies it becomes necessary, therefore, to recognize and eliminate from consideration those variations falling outside the class of those having taxonomic worth.

For purposes of the present study variations within a single Rassenkreis may be considered to fall into 4 major categories.

1. Secondary sexual variation.
2. Age variation.
3. Individual variation.
4. Geographic variation.

Secondary Sexual Variation

Geographic races of *Odocoileus hemionus* show marked difference in the amount of this variation. The more northern races, *hemionus, sitkensis* and *columbianus,* display a much greater disparity in size between the sexes than do the more southerly ranging forms such as *fuliginatus* and *peninsulae.* The females of the several races differ less from one another than do the males. Secondary sexual variation in deer extends to actual and relative proportions of bodily parts to a varying degree, to color pattern in a very slight degree, and to skull size in greater degree.

In general it can be said that adult females are smaller than adult males. The difference in weight is relative as well as actual; the females are more lightly built. Indication of the amount of this variation is provided by specimens of *O. h. columbianus* from near Chico, Butte County, California, three adult males of which averaged 207 (172–238) pounds, while three adult females from the same locality averaged only 102 (92–116) pounds. The same three males averaged 1588 (1525–1620) millimeters in total length and the same three females 1402 (1300–1455) millimeters. This population, then, showed a difference in total length between the sexes amounting to almost 12 per cent and a difference in weight amounting to almost 51 per cent. The difference in weight here indicated may be in part seasonal. All were collected in October, at which time the males are at their heaviest and the females often in a poorer condition as a result of their summer's maternal duties. Length of tail and length of ear each is approximately the same in the two sexes, but the metatarsal gland averages shorter in the females.

Secondary sexual variation in color was detected only on the head. The males of certain races have the face markings more highly contrasted. In these races the brow patch is darker in the males, being almost black, while the nose and sides of the face are light gray or white. This variation is less pronounced in the summer pelage than in the winter one. The contrasted color pattern undergoes some variation also with age. Older individuals show greater contrast than young ones of the same race. The facial markings of the females, on the other hand, are more subdued; the nose and sides of the face are darker gray, and the brow patch is inconspicuous. The color differences outlined above are most marked in *O. h. hemionus,* are less

marked in *O. h. columbianus*, and, so far as the available material shows, do not occur in *O. virginianus*.

The possession of antlers by males more than one year old and their absence in females of all ages is the most noticeable secondary sexual character of the genus (see page 181 for an account of the antlers). The development of these large and prominent exostoses, antlers, by the adult male deer would reasonably be expected to be accompanied by a notable modification of the associated parts of the skull. Actually the crania of the two sexes do not differ widely. The skull of the female is uniformly smaller in all parts studied save those directly associated with the teeth. The alveolar length of the upper molar series is almost the same in the two sexes and therefore relatively greater in the female as compared with the basilar length of Hensel. The same relation prevails with respect to the lower molar series. In this connection it is interesting to note that the relatively long tooth row is a primitive character ontogenetically; the ratio of the tooth row to the basilar length of Hensel decreases progressively with age. Of the other cranial dimensions studied, orbital width is the only one found to be markedly less variable in the male. The part of the skull concerned is directly associated with the development of the antlers.

Certain other secondary sexual variations are displayed only at certain seasons of the year. The swollen neck of the rutting male in autumn is perhaps the most obvious of these.

In addition to the mentioned secondary sexual structural features there are psychological and physiological differences not certainly to be regarded as sexual variations. One such is the greater sensitivity to sunlight of males which Dixon (1934:209) thought that he detected in *O. h. californicus*. Since that author's studies were made for the most part in National Parks, the selective persecution of the males can not be invoked to explain such behavior. Males in good health usually molt two weeks to a month earlier than does. Barren does molt as early as the males, so that possibly physical well-being more than any fundamental secondary sexual difference is responsible for the variation. The psychological differences are for the most part directly related to the reproductive behavior and the rearing of young—subjects outside the scope set for this account.

Age Variation

Age variation in deer is not pronounced after the fourth or fifth year. Its manifestations are most apparent in body size, color of the head of males, antler rugosity and certain cranial features. In the absence of sufficient data not much can be said concerning the increase in body size and weight with advance in age, save that such does take place.

Sheldon (1933:10), referring to *hemionus*, makes the statement that as the animal increases in age the pelage becomes darker. However, my own examination of large numbers of specimens fails to reveal any such general color difference referable to age. It is true that males of certain races do show considerable whitening of the face and nose in old age. No corresponding change takes place in the

females, which indeed show little variation definitely attributable to the age factor.

Up to a certain age, probably that of maximum vigor, the antlers by their size alone, but more particularly by increase of basal circumference, show marked age variation. The number of tines, however, contrary to a popular misconception, gives no reliable indication of age once maturity (an age of 4 or 5 years) is reached. The antlers of old males have a greater basal circumference and are pronouncedly rugose at the bases; these parts are studded with large and small nodules.

The cranial changes associated with advancing age are more numerous and easier of appraisal. Those which occur in later life may be summarized as follows: Lateral pinching of the nasals with accompanying elevation of the dorsal outline of the rostrum, imparting the "Roman-nose" effect to very old males. This is associated with depression of the fronto-nasal region and is more pronounced in *O. h. hemionus* and *O. h. peninsulae* than in the other races. Other age variations of the cranial region include elevation of the frontal region between the antler pedicels, and broadening and increased rugosity of the occipital region. The latter is particularly obvious in the increased prominence of the occipital crests.

Development of the Skull in Odocoileus hemionus columbianus

Odocoileus hemionus columbianus was chosen for the study of skull changes with increasing age, because specimens of many ages were available, whereas fewer were available of the other kinds of deer. Twenty specimens under one year old were examined in addition to many male skulls between one and two years of age, and, of course, a large number of adult male skulls.

No difference in the skull attributable to sex was found prior to the time of appearance of the frontal pedicels. Consequently, up to the age of two and one-half months, indiscriminate use was made of material of both sexes. Of older animals only males have been used. The three youngest specimens chosen for detailed study were selected from several embryos in alcohol; otherwise all skulls were cleaned and prepared by the usual museum methods.

Twelve specimens selected as characteristic of as many growth stages up to one and a half years of age are listed below. The ages noted as only approximate have been estimated by counting backward from the date of collecting to the average date of birth for fawns in the locality concerned, and from the animals' degree of development in comparison with other specimens, some of which were of known age. All catalogue numbers are those of the Museum of Vertebrate Zoology.

No. 32880; male, *columbianus*, near Sunol, Alameda Co., Calif., March 11, 1922. Known to be a 3-months embryo; captive doe bred December 10, 1921, and died March 11, 1922.

No. 28768; male, *columbianus*, St. Helena, Napa Co., Calif., February 16, 1917. Age, approximately 4-months embryo.

No. 33647; female, *columbianus*, San Andreas Lake, near Millbrae, San Mateo Co., Calif., March 25, 1924. Age, approximately 5-months embryo.

No. 479; female, *sitkensis*, Windfall Harbor, Alaska, April 30, 1907. Age approximately 5½-months embryo.

No. 12060; female, *columbianus*, Alberni, Vancouver Island, B. C., June 11, 1910. One day old.

No. 12061; female, *columbianus*, Golden Eagle Basin, Vancouver Island, B. C., July 4, 1910. Age, approximately 1 month.
No. 12059; sex ?, *columbianus*, Errington, Vancouver Island, B. C., September 5, 1910. Age, approximately 2 to 2½ months.
No. 12054; male, *columbianus*, Errington, Vancouver Island, B. C., August 30, 1910. Age, approximately 3 months.
No. 12056; male, *columbianus*, Errington, Vancouver Island, B. C., September 9, 1910. Age, approximately 3½ months.
No. 38898; male, *columbianus*, Laytonville, Mendocino Co., Calif., January 15, 1928. Age, approximately 8 months.
No. 13014; male, *columbianus*, North Fork of Coffee Creek, Trinity Co., Calif., July 5, 1911. Age, approximately 13 months.
No. 11730; male, *columbianus*, 5 mi. S. Kunz, Trinity Co., Calif., September 21, 1909. Age, approximately 15 months.

In studying the growth changes which occur between the ages of 15 and 24 months, and again between 24 months and old age, the average measurements of series of skulls judged to be of about the same age have been used. The old adult, No. 25386, shown in figures 51, 52 and 53, was taken on Redding's Creek, near Douglas City, Trinity County, California, in September, 1916.

The tables of measurements and detailed accounts of growth and development of individual skull elements prepared during the study now reported upon are omitted from the present account but are on file in manuscript form in the University of California Library, where they may be consulted by those interested.

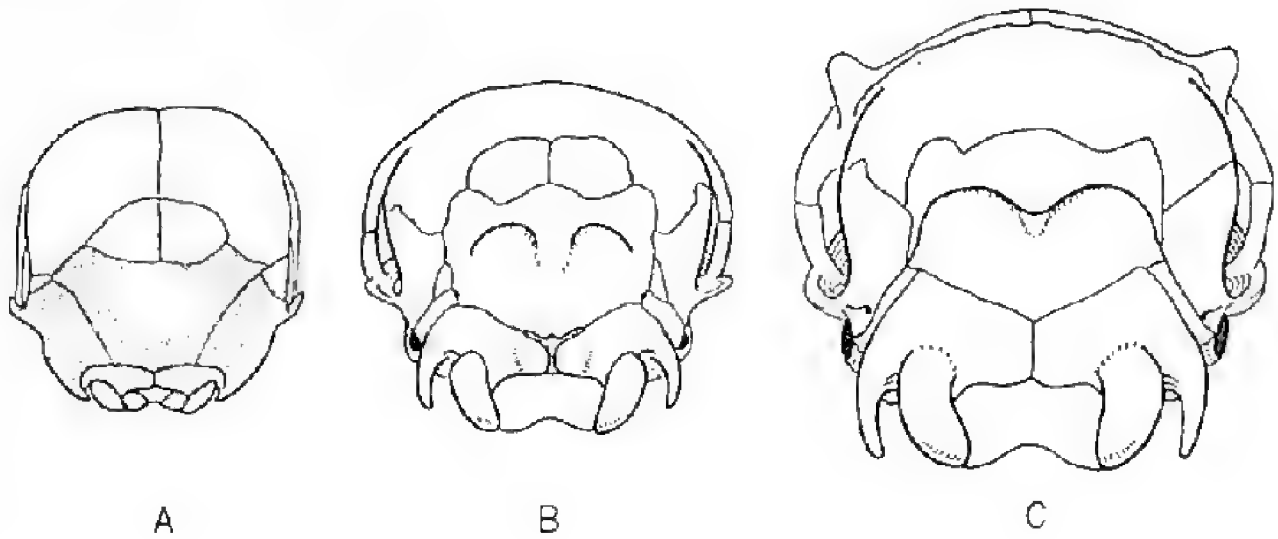
As an aid in summarizing these changes for the skull as a whole I have shown in table B the numerical value of, and the per cent of increase taking place in, certain selected measurements for animals of five different ages. These groups were chosen on a basis of approximately equal increments in basilar length.

For the purpose of this study the cranium has been arbitrarily divided into three sections: an anterior section consisting of that portion of the cranium anterior to the fronto-nasal suture; a median section, consisting of the part roofed over by the frontals; and a posterior section, comprising the remaining portion of the cranium. The palatal width has been used as indicative of the transverse growth of the anterior segment; the zygomatic width, of the median segment; and the mastoid width, of the posterior segment.

The data in table A are tabulated so as to show the increase in the three sections of the skull in three planes, with respect to age, relative amount, and percentage of this increase. It can be seen that the greatest amount of increase in all three planes takes place in the anterior, or preorbital, section. The posterior section is the most stable.

The relatively large size at birth of that part of the skull enclosing the brain is, so far as I am aware, the common condition throughout the Eutheria.

From table B it may be seen that while the basilar length increases only 107.5 per cent, the nasal length increases 191.4 per cent; and the increases in length of the other two dorsal elements are 61.4 per cent in the frontals, and 30.9 per cent in the parietals. A similar indication of greater growth in the anterior regions in postnatal life is found in the basal plane of the skull. Here the palatal length increases 117 per cent from birth to maturity, while in the same period the postpalatal region increases only 74.9 per cent.



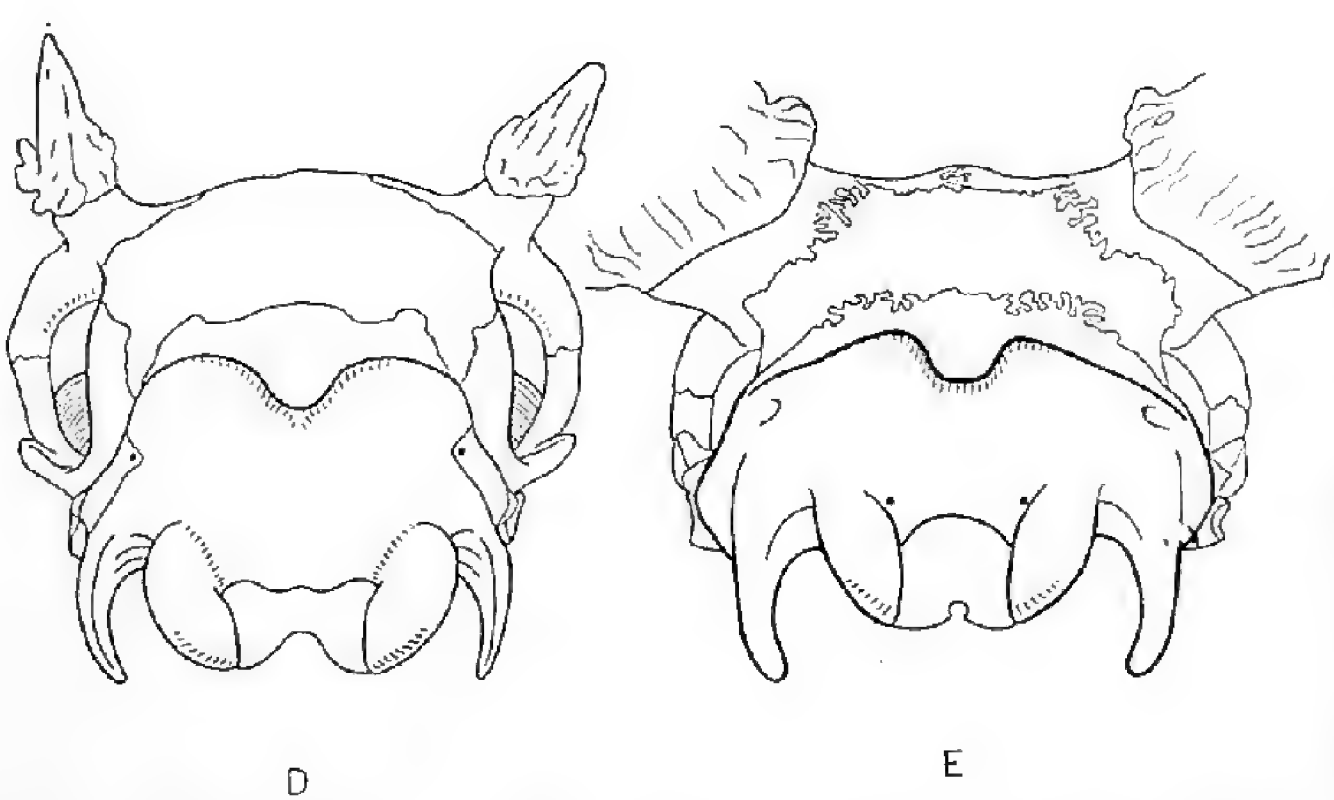


FIG. 51. Posterior (occipital) views of crania of *Odocoileus hemionus columbianus*. A. 3-months embryo, no. 32880, x 1. B. 2 to 2½ months old fawn, no. 12059, x ½. C. 3 months old, no. 12054, x ½. D. 15 months old, no. 11730, x ½. E. Old adult, no. 25386, x 9/20. For locality and other data see pp. 162, 163.

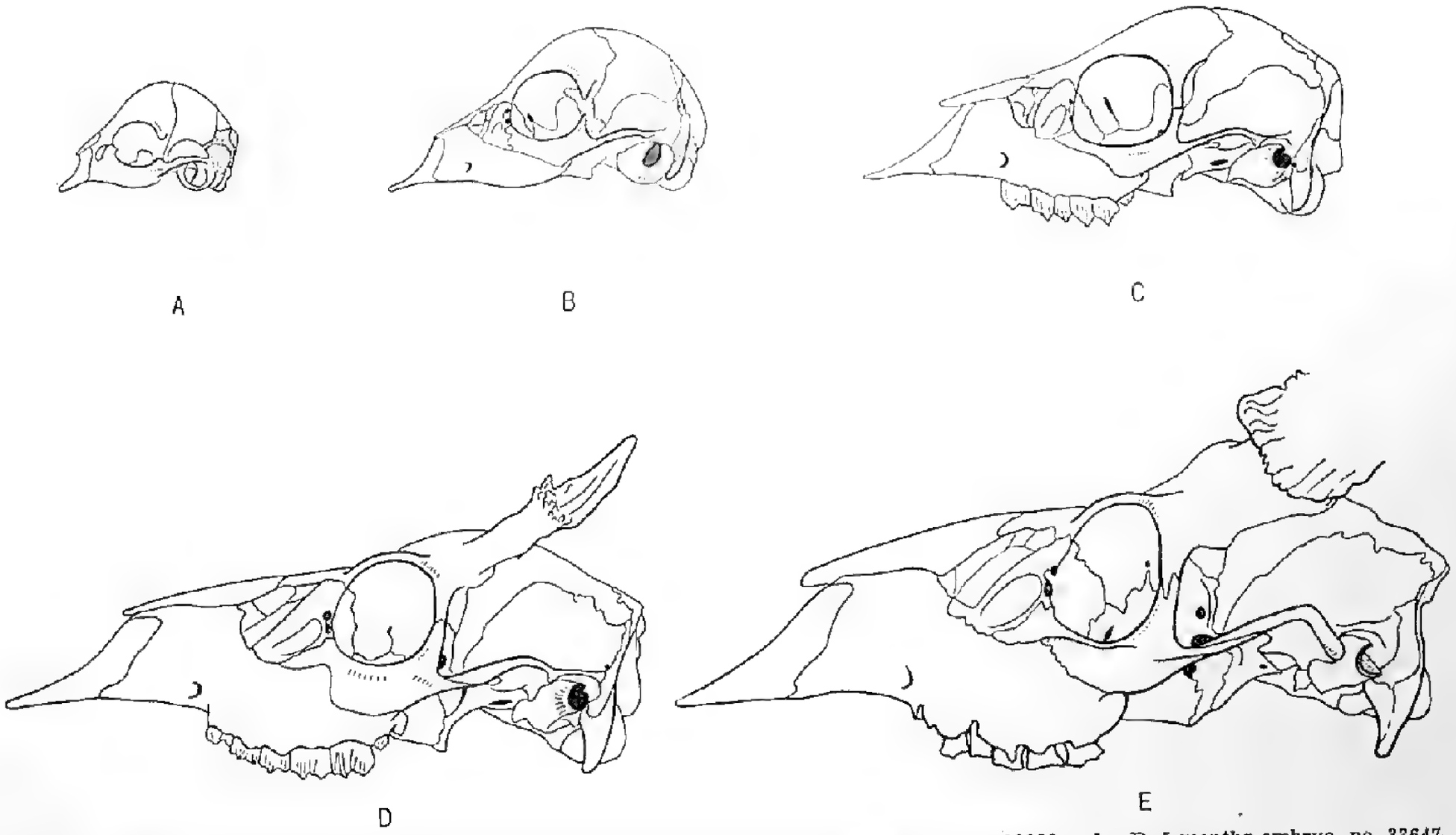


FIG. 52. Lateral views of cranla of *Odocoileus hemionus columbianus*. A. 3-months embryo, no. 32880, x ½. B. 5-months embryo, no. 33647, x ½. C. 2 to 2½ months old fawn, no. 12059, x ½. D. 15 months old, no. 11730, x 7/20. E. Old adult, no. 25386, x 7/20. For locality and other data see pp. 162, 163.

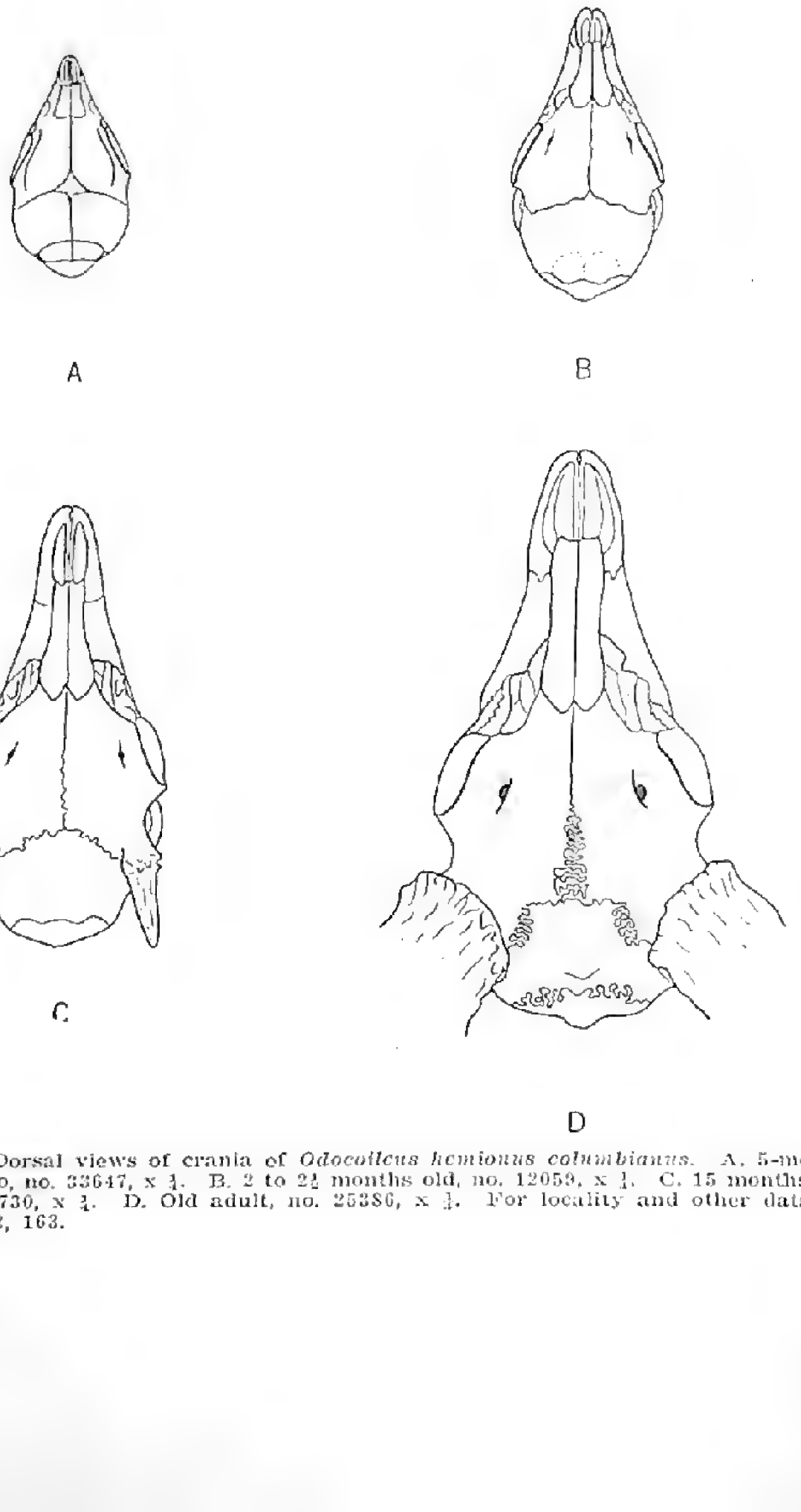


FIG. 53. Dorsal views of crania of *Odocoileus hemionus columbianus*. A, 5-months embryo, no. 33647, x ¼. B, 2 to 2½ months old, no. 12059, x ¼. C, 15 months old, no. 11730, x ¼. D, Old adult, no. 25386, x ¼. For locality and other data see pp. 162, 163.

From graph 1 it can be seen that just prior to birth the nasal region increases rapidly in length, relative to the basilar length; while the parietal segment undergoes a corresponding decrease in relative length. However, in the 2½ months immediately succeeding birth the parietal segment undergoes an increase of 30.9 per cent, the frontal segment increases 10.6 per cent and the nasal one 16.7 per cent. After 2½ months of age, however, the parietal is a relatively stable element actually increasing but little and decreasing relatively from 34.4 per cent at 2½ months to 22 per cent in the adult.

The transverse development of the median and posterior sections of the cranium, as expressed by the zygomatic and mastoid widths respectively, show an actual increase of 74 per cent and 72.7 per cent respectively, though both undergo a progressive decrease in relative size during development. This decrease in relative width obtains in all parts of the cranium measured except in the palate whose width increases more rapidly than does the basilar length.

Measurements of depth similarly show greatest growth in the anterior segment. Between birth and one month of age the frontal section increases rapidly in depth, but, in the period of life succeeding this, the palato-nasal depth shows a progressively more rapid increase in relative magnitude.

Of the three sections of the cranium the anterior is the only one exhibiting a relative increase in depth; the median section shows a slight relative decrease, and the posterior section does so in still greater degree.

The accompanying graphs indicate, as was suggested by Huxley (1932:118), the existence of two distinctly different phases of growth. The line traversing the graphs transversely is the birth line; below it is charted embryonic growth; above it postnatal growth. There appears, then, as regards growth in all three planes, to be a period before, and immediately subsequent to, birth characterized by rapid alterations in the form of the cranium. This determinative period persists until the age of approximately 3 months when it is followed by a period, lasting at least until the adult condition is attained, in which certain more or less constant relative growth forces are in action, and the skull changes steadily along certain definite lines.

TABLE A

Relative Amounts of Growth in Length, Width and Depth, in the Different Regions of the Cranium, and the Ages at Which This Increase Occurs

	Preorbital	Interorbital	Postorbital
Length	Most (3–13)*, 72.5%	Inm. (3–13), 18.8%	Least (0–2½), 30.9%
Width	Most (0–2½), 59%	Inm. (2½–3), 25.6%	Least (2½–3), 22.8%
Depth	Most (3–13), 46.2%	Inm. (13–24), 24.4%	Least (2½–3), 17.1%

* Numbers in parentheses are age groups in months. Age groups selected on basis of approximately equal increment in basilar length.

TABLE B

Actual and Relative Development in Cranial Sections After Birth

	Age in months	Basilar length	Palatal length	Postpalatal length	Nasal length	Frontal length	Parietal length	Palatal width	Interorbital width	Zygomatic width	Mastoid width	Palato-nasal depth	Fronto-palatal depth	Occipital depth
	0	105.6	68.4	37.5	22.7	45.2	34	12.2	35.5	55.6	38.5	21	46	28.6
	2½	120.5	85	45.5	26.5	50	41.5	17.8	41	61.7	44	28	57	33.1
%	------	22.6	21.4	21.1	10.7	10.6	30.9	45.9	15.5	16.3	14.3	33.3	23.9	15.7
	3	158	102.3	55	30	58	30.5	25	48	79	52.8	36.5	61.9	38
%	------	27	25.3	25.6	41.7	17.7	11.7	50	19.7	25.6	22.8	40.5	17.1	17.1
	13	188	130	58	52.5	66.5	46.6	29.4	57.6	93	59.8	46.2	69	39.5
%	-----	28.4	40.5	8	72.3	18.8	20.8	36	27	35.2	18.2	46.2	8.9	5.3
	24	219	148.4	65.5	66.2	73	44.7	25.9	65.5	97.2	66.5	51.5	80.7	42.5
%	------	29.4	26.9	20	60.4	14.3	6.2	28.7	22.2	7.5	17.4	39.5	25.4	10.5
Total %	------	107.5	117	74.9	191.4	61.4	30.9	112	84.5	74	72.7	159	75.5	48.5

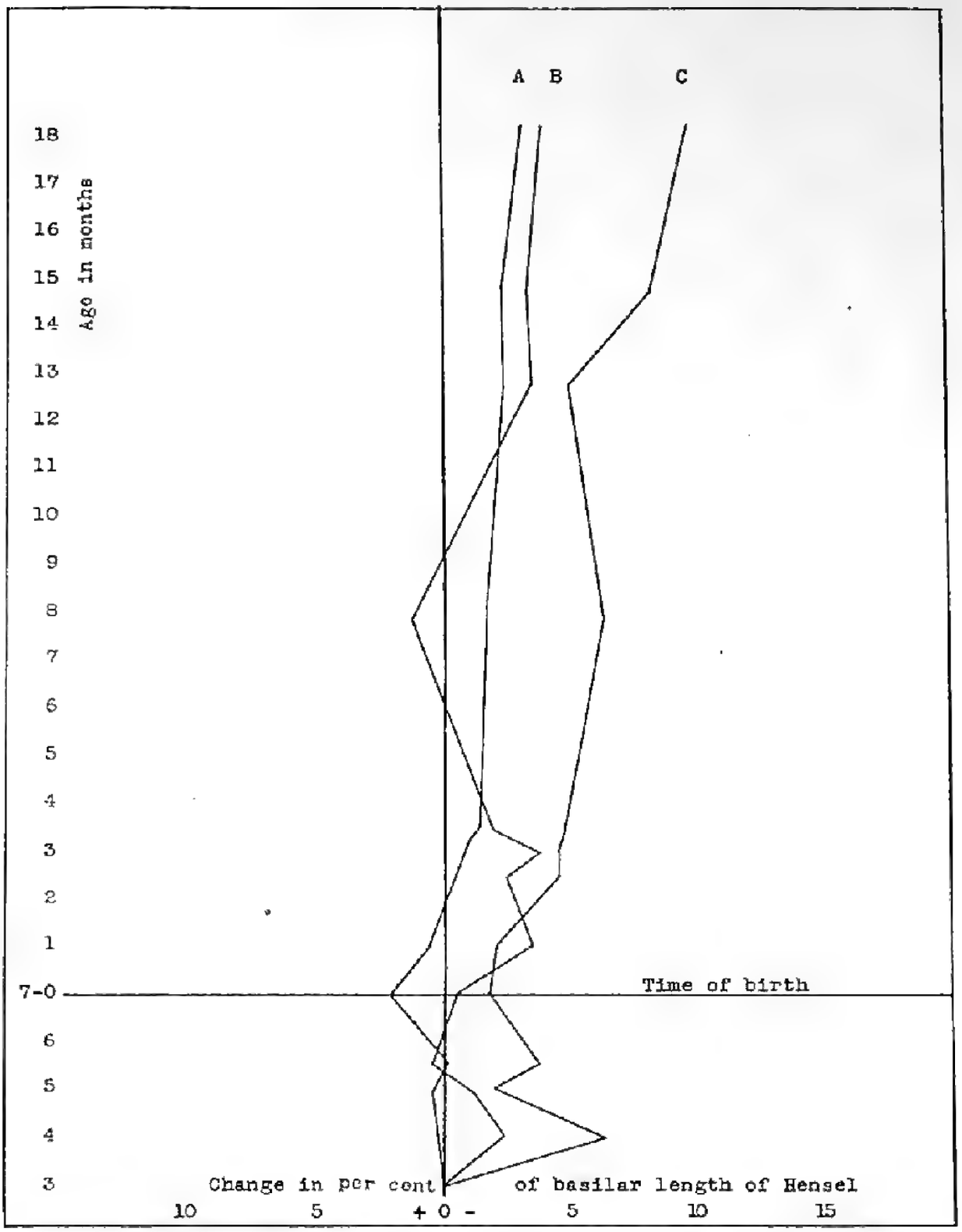
In these graphs, 1 is not strictly comparable to 2 and 3, in which latter two the growth of each of the sections is compared with a definite, independent factor, the absolute increase in the length of the cranium. In 1 the lengths of the various sections are expressed as a percentage of the total length and, therefore, are being compared with a measurement of which they themselves form a component.

From the standpoint of taxonomic value, those measurements which show least relative change, where they do not undergo great secondary sexual or individual variation, are ones in which geographic variation is most easily detected. Of the 22 skull measurements included in this study, those showing the least amount of fluctuation in relative size attributable to the age factor are width of external nares, least width of nasals, least interorbital width, length of external nares, mastoid width, length of nasals, palatal length and palatal width. Several of these measurements have, in fact, proven useful in distinguishing geographic races.

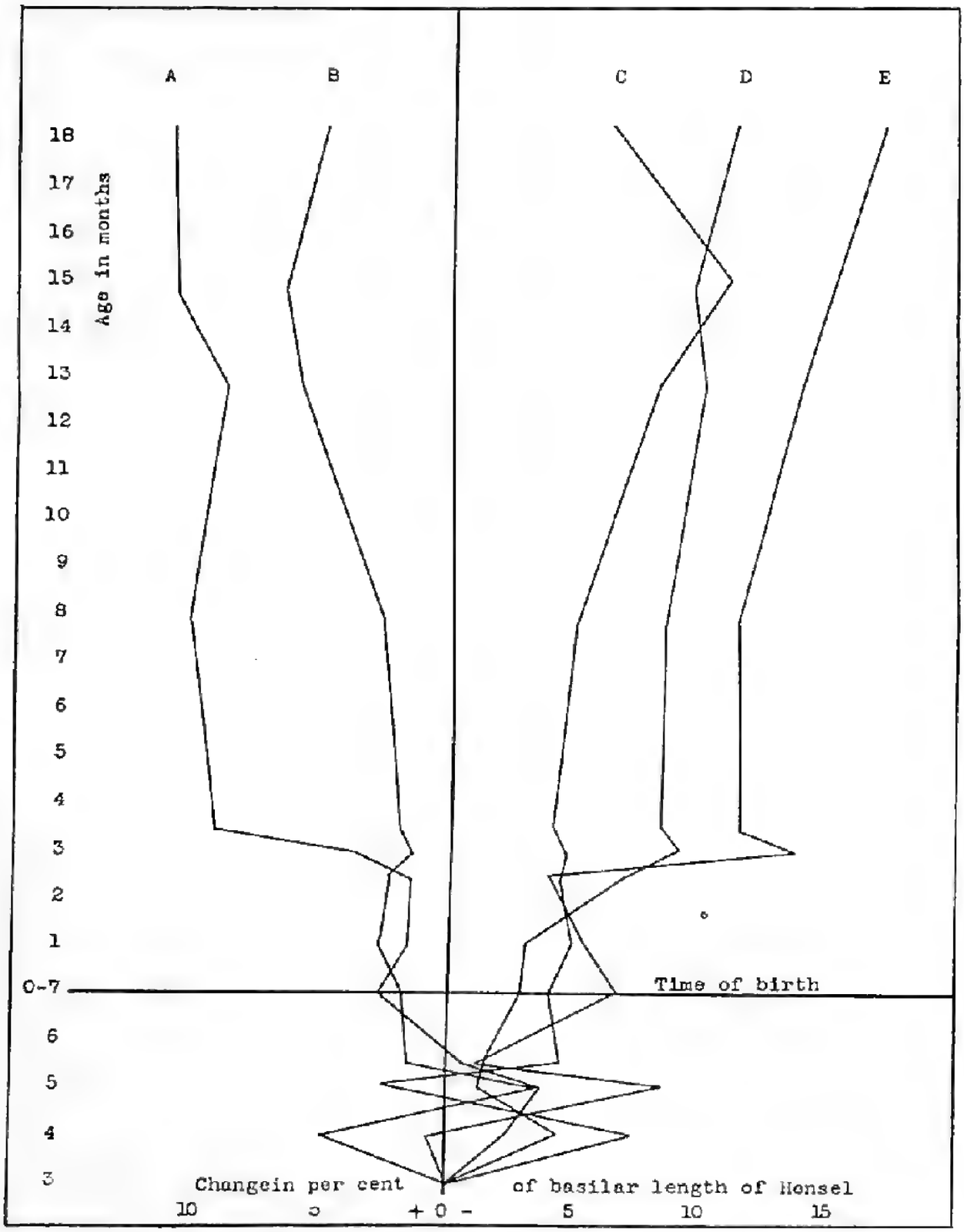
Individual Variation

Under this heading I include all those variations from the general pattern of the species not known to be correlated with sex, age and point of geographic origin. Consequently, within this class there may be found such features as are induced by the environment in the individual's lifetime and also ones possibly resulting from the mating of parents belonging to the same race but of slightly different genetic strain.

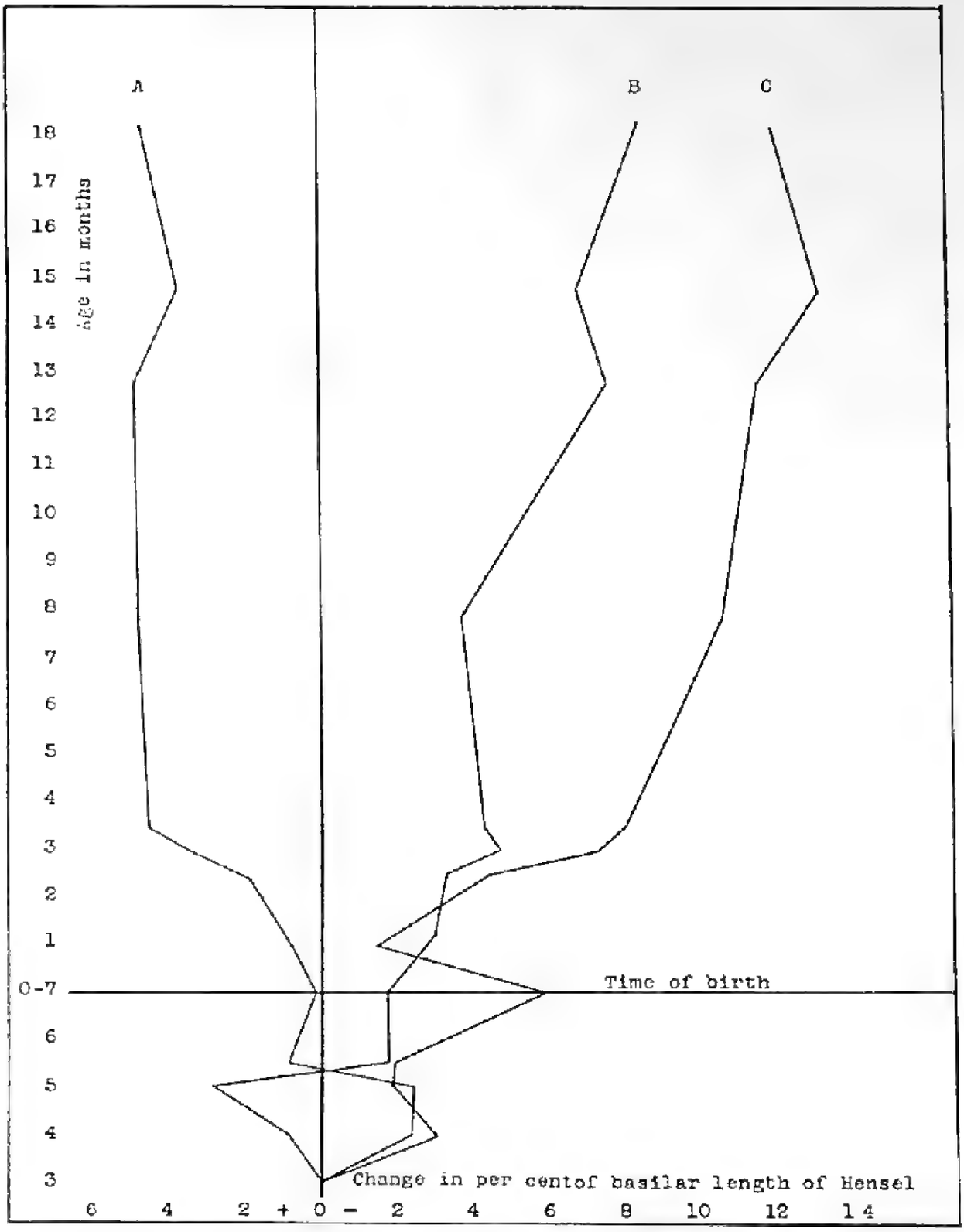
Numbers of writers have remarked upon the variation in body weight in the genus, occasional individuals being found that are almost double the normal in this regard. Many adult male mule deer (*O. h. hemionus*) scale less than 200 pounds dressed, but Hunter (1924:19) reports two bucks of this race that weighed 380 pounds and 350 pounds dressed. Seton (1929:232) records many weights of similarly heavy white-tailed deer. These abnormally heavy deer are often extremely fat; possibly this results from some glandular disturbance.



GRAPH 1. Changes in ratio, of certain cranial parts, as expressed in percentages of basilar length of Hensel. A. mastoid width; B. interorbital width; C. zygomatic width.



GRAPH 2. Changes in ratio, of certain cranial parts, as expressed in percentages of basilar length of Hensel. A. nasal length; B. palatal length; C. postpalatal length; D. frontal length; E. parietal length.



GRAPH 3. Changes in ratio, of certain cranial parts, as expressed in percentages of the basilar length of Hensel. A. palato-nasal depth; B. occipital depth; C. fronto-palatal depth.

Sheldon (*loc. cit.*) and Moffitt (1934:86) among others have remarked upon the inadvisability of depending on color to distinguish the different races of deer because of the wide variation in color of a single kind. This variation, however, is due to individual differences in time of molt more often than to any considerable individual variation in color pattern. At any one time in any locality deer will be found in many stages of molt, regrowth or wear of the pelage, and it is these factors which explain most of the observed variation.

Large series of skulls of *O. h. columbianus* and *O. h. californicus* were studied in an effort to determine the degree of variation taking place in several cranial measurements. Individuals of similar age and as far as possible from one locality were relied upon. Among 22 measurements taken, variation from the maximum ranged from as much as 20 per cent to as little as 3 per cent. The nasal measurements, orbital width, mastoid width and palatal length vary most. Palatal breadth and measurements concerned with the tooth rows vary least. For every measurement the amount of variation was different in the different races and even in the different populations of the same race. The characters which show least individual variation show also least age and secondary sexual variation.

Geographic Variation

In the genus *Odocoileus* it is possible to divide variations of a geographic nature into the two main types:

1. General trends, usually occurring under similar gradients of environmental conditions, and extending for long distances geographically.
2. Inconstant features apparent only for limited distances.

The geographically variable species *Odocoileus hemionus* exhibits many examples of the first type, of which tail color is one of the most striking. At the northern limit of the range of the species, in *sitkensis*, the tail is largely brown above with the black on the tip much reduced or absent. In southern British Columbia individuals assigned to the race *columbianus* have the tail brown with the terminal third black. Approximately the same condition prevails throughout Washington, Oregon and as far south as the coast of extreme northern California. Still farther south on the coast as far down as Marin County, there is a marked tendency for the black of the tip to encroach upon the proximal portions of the tail. In Marin, Alameda, Santa Clara and Santa Cruz counties, at the southern end of the range of this race, most of the deer have the entire dorsal face of the tail black. A parallel condition is found to the eastward where the race *hemionus*, from the northernmost extension of its range in British Columbia, south as far as northern California and Nevada, possesses a white tail with a black tip. Meeting and intergrading with this race in northern California is the race *californicus*, which has the brown of the back extending down the tail to a greater degree; still farther south, in San Diego County, California, and in northern Lower California the race *fuliginatus* has a black or blackish band extending the entire length of the tail dorsally. In some individuals the entire dorsal surface of the tail is blackish. In the coastal deer this progressive increase south-

ward in pigmentation of the upper side of the tail is not accompanied by other characters which warrant the recognition of more than the two races *sitkensis* and *columbianus*. In *columbianus* south of Santa Clara County, California, the darkening of the tail may have been intensified by cross breeding with *californicus*. In the mule deer group to the eastward, on the other hand, this gradation in tail pigmentation is here and there accompanied by other characters and makes necessary the recognition of four geographic races.

The ear displays a progressive reduction in size from a maximum in *hemionus* to a minimum in *sitkensis* by way of the races *californicus* and *columbianus*. Size of rump patch, length of metatarsal gland, degree of nakedness of ventral surface of tail and size of antlers, all exhibited in maximum degree by *hemionus*, undergo a similar reduction along a U-shaped path terminating in *sitkensis*.

The intensity of coat color seems to be somewhat correlated with the humidity of the environment as is known to be the case in many mammals and birds. Those races living in the humid coastal region have the darkest pigmentation, and the desert forms the lightest pigmentation.

Boetticher (1915:47) correctly states that the races of the genus *Odocoileus* conform to Bergman's Law in that the individuals of races inhabiting the colder localities are larger than those of races inhabiting the warmer regions. The single exception noted was *O. h. sitkensis*. Really this form is not an exception, because *sitkensis* exceeds its southern representative (*columbianus*) in size.

The northern races are not only larger than their southern counterparts but display also greater sexual dimorphism in size of body.

Under the heading of inconstant trends of geographic variation fall most of the cranial characters exhibited by the various races.

The geographic variations noted include ones commonly considered as diagnostic of races, along with some others possibly attributable to immediate environmental conditions. The latter are thought of as characterizing ecologic races or populations. A discussion of these may be found in the account of *O. h. columbianus*.

PELAGE AND MOLT

Pelage succession and types of hair seem to be fairly constant throughout the genus. The description following is that for *O. h. columbianus*. Just prior to birth the upper parts of the body are covered with a coat of fine hair of two kinds. One is about one-eighth inch in length and of a color between Prout's Brown and Dresden Brown. The other is comprised of numerous very fine, silky, black hairs, approximately one-half inch in length. Commencing on the dorsal surface of the neck midway between the bases of the ears, two parallel white stripes extend caudad to the base of the neck, from which point they proceed posteriorly, as parallel lines of white spots, to unite and terminate on the dorsal base of the tail. The remainder of the upper surface of the body from shoulder to thigh is irregularly spotted with white. A noteworthy feature of these white spots is that they are composed of hairs differing from those of the remainder of the dorsal surface in being coarser and of greater length. These two features

cause the white spots to be elevated above the general level of the pelage. Other parts of this pelage may be described as follows: Crown and sides of head near Ochraceous-Tawny (capitalized color terms are from Ridgway, 1912); cheeks and nose lighter; and summit of crown and area between eyes intermixed with black; black U-shaped mark, with apex directed anteriorly, starting above each eye extends anteriorly to unite on mid-line of nose anterior to eyes, from which point a black line extends down mid-line of nose to base of rhinarium; rhinarium and upper lips black; ears blackish brown outside, lighter toward tip and posterior margin; inside, anterior margin, and spot at base of ear posteriorly, white; chin crossed by black bar; sides of body and outside of fore legs Vinaceous-Buff, becoming darker and browner on brisket and mid-line of chest; throat, lower lip, belly, inside of fore legs, and inside of hind legs to and including ankle joint, white; lower legs dusky brown; tail characteristic of the race but with color pattern subdued.

In the two months prior to birth the hair grows rapidly and becomes very much lighter in color, until at birth the fawn is clothed in a thick coat of soft kinky hair. At this time the general color of the dorsal surface approaches Mikado Brown, becoming lighter on the sides. The tip of each hair is black, and the base lighter brown. The white spots are still elevated above the general level of the pelage, but only the terminal third of the hairs comprising these spots is white; the basal part of the same hairs is of finer texture and has the same brown color as the rest of the pelage. Other features noted at this age are: crown patch indistinct; black U-shaped mark between eyes and black line down nose prominent; ventral surface of neck and brisket Light Cinnamon Drab; ears outside brown, inside white; lower legs, thigh, and outside of fore leg, near Pinkish Cinnamon; site of tarsal gland marked by tuft of elongate, stiff, grayish white hairs; woolly under fur important element of coat throughout immature life.

During the four months subsequent to birth, exposure to the elements gradually bleaches the coat to a dull brown; at the same time abrasion removes the tips of the hairs, particularly those of the hairs making up the white spots, so that at the age of 4 months these spots are but faintly indicated. At this time the first autumnal molt occurs, and the fawn enters the first winter in a long silky coat of drab colored hair. The color pattern is much the same as in adults of the same race, but less contrasted. With the assumption of the first summer pelage the yearling becomes indistinguishable from the adults in so far as pelage is concerned.

The material available indicates that in *O. h. hemionus* the pelage of fawns is more yellowish brown at each postnatal stage than in *columbianus*. Furthermore, the more rigorous environmental conditions within the range of the mule deer fosters a more rapid wear and bleaching of the hairs, with an earlier elimination of the white spots.

As has been emphasized by Dixon (1934:263) there is considerable variation in the color of fawns at birth, and this same difference probably extends to subsequent stages of pelage.

The pelage of deer of all ages in the genus *Odocoileus* is made up of two general types of hair, a heavy coat of long, coarse, kinky hair and a sparse coat of very fine woolly hair. The amount of the latter

becomes progressively less as adulthood is approached. The guard hairs vary in coarseness with the age of the individual until full maturity is attained; younger individuals have finer hairs.

All the races so far examined undergo two molts each year, one in the spring, another in the fall. Though the actual times of these molts vary with the geographic location of the individual, it can, nevertheless, be said that the majority of races undergo the fall molt in August and September, the spring molt in May and June. Normally males acquire the winter pelage almost a month earlier than the females with fawns.

The molt follows no definite sequence as regards areas of body involved. In members of the *hemionus* group, which for the most part inhabit territory devoid of heavy brush, the new coat is often apparent first upon the flanks—a condition brought about by the excessive wear on these parts in animals living under semidesert conditions. In the brush-inhabiting races, such as *O. h. columbianus*, the new pelage is more often first apparent on the legs and lower parts of the body. This also is accounted for by the differential action of the environment; wear serves to remove the old hairs first on these parts. The new hair grows in more or less evenly over the entire body surface, and is fairly well developed before the shedding of the old pelage exposes it to the action of the environment.

The hairs of the summer and winter pelages differ markedly with respect to coarseness, kinkiness, length and pigmentation. The summer or "red" coat is composed of shorter, finer, less kinky hair, white at the base, and on the dorsal surface grading into a reddish brown or yellowish brown terminal portion; sometimes the extreme tip is black. This is replaced in the autumn by the "blue" pelage of winter which is composed of longer, coarser, more kinky hairs. The length of the winter coat varies greatly with geographic situation, the longest, densest, winter hair-covering being displayed by *O. h. sitkensis* and the shortest by *O. h. peninsulae*. The pigmentation pattern displayed by the hairs of the winter pelage is very different from that of the corresponding hairs of the summer pelage. In a winter hair from the dorsal surface of the animal the tip is black for a varying length and is followed by a band of yellowish or reddish brown also of varying width; this in turn is succeeded by the basal area which is either plumbeous or brownish in the geographically variable species *hemionus*, and pale brown to whitish in *O. virginianus*. In this basal area the color is darkest distally and becomes progressively lighter proximally.

The general color tone of the dorsal parts of the body, then, depends primarily upon the stage of hair growth. When the hair is short, a dark color prevails due to the predominance of the black tips, but as the hair increases in length, the color becomes lighter. However, the color attained with full growth of the hair is maintained for only a relatively short period. The hollow hairs, once dead in their entirety, are quickly abraded in those races inhabiting the less humid districts. The black tips break off first, and this loss is succeeded by the elimination of the subterminal light band, all of which greatly modifies the coat color of the individual. Coupled with this abrasion, and of greater importance in *O. h. sitkensis* and *O. h. columbianus*, is an actual fading of the hairs. Deer wintering in deep snow have hairs

on the lower sides and legs extensively bleached and abraded. A well defined "snow line" appears along their sides. The wear and abrasion of the pelage plays a prominent part in the shaping of the tail in the various members of the mule deer group, the basal hairs undergoing greater wear than the more terminal ones. This accentuates the basal constriction of the tail always found in these races. Because of variations just remarked upon, and others correlated with the individual, age and sex it must be said that coat color *per se* is of relatively little systematic value in the absence of large numbers of specimens.

THE TAIL

Except in areas of intergradation, the external form and the color pattern of the tail provide a fairly reliable and readily appraisable means of differentiating certain kinds of deer in life.

Numbers of vertebrae.—Mearns (1907:212) suggests a possible difference in the number of caudal vertebrae as a specific distinction. He states that *Odocoileus couesi* has 11 long vertebrae in the tail, while *O. h. californicus* has 9 shorter ones. The examination of approximately 50 specimens of the various races of *O. hemionus* has, however, led me to the conclusion that no such constant difference exists. I have found the caudal vertebrae to vary in number from 8 to 11, irrespective of race or sex. Mearns had few specimens, and the variations he found were probably fortuitous.

Tail length.—Seton (1929:231 and 232) gives tail measurements of *O. virginianus* of 6 inches (152 mm.) and 11½ inches (292 mm.). In my experience the former is abnormally short and the latter nearer the average length. In 25 specimens of *O. h. hemionus* I find the combined tail vertebrae to vary in length from 4½ inches (114 mm.) to 8 inches (203 mm.) the average being 6½ inches (165 mm.). The tail vertebrae of *O. h. columbianus* are somewhat longer than those of *hemionus*, varying from 7 inches (173 mm.) to 7¾ inches (192 mm.). and averaging approximately 7½ inches (185 mm.).

Tail form and color.—The tail of *O. virginianus* is typically long and broad without a basal constriction and without a terminal brush. The upper surface is uniformly brown, the particular shade varying individually and geographically. The lower surface is covered with long white hairs that extend laterally to beyond the dorsal brown hairs to produce a white marginal fringe. This species is remarkable for the length of the tail hairs. In a winter specimen from Oregon the lateral white hairs are three to four inches in length. This variation in the length of tail hairs, both *en masse* and on the different parts of the organ, is largely responsible for the characteristic tail shapes presented by the different species and in some cases, also, by the different races of deer. Seasonal variation in this respect also produces radical changes in tail shape from one pelage to the next.

O. h. hemionus has the tail constricted at the base and provided with a terminal brush. The brush is most apparent in summer or worn winter specimens. The lower surface of the tail of this race is naked for the proximal one-half to two-thirds of its length. In *O. h. eremicus* the naked area is even more extensive. Typically *hemionus* has the basal portions of the tail white all around and the terminal

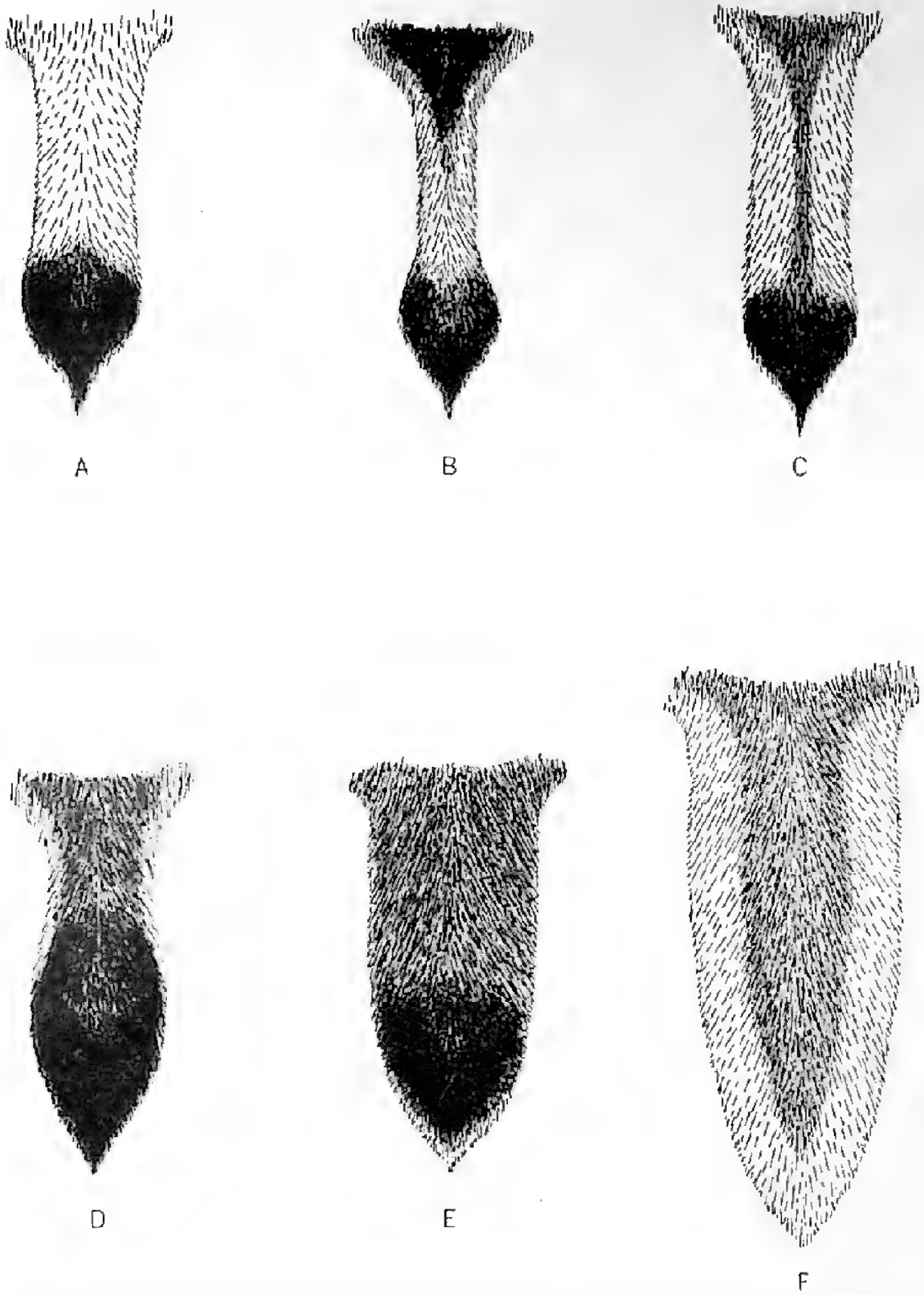


FIG. 54. Dorsal views of tails of some races of deer inhabiting western North America. Drawings are roughly ¼ natural size. A. *Odocoileus hemionus hemionus*. B. *O. h. peninsulae*. C. *O. h. californicus*. D. *O. h. columbianus*. E. *O. h. sitkensis*. F. *O. virginianus ochrourus*.

brush black. In other members of the mule deer group a dark line of varying width and intensity extends down the dorsal surface for a longer or shorter distance. In outline, the tail of *O. h. columbianus* lacks the basal constriction; the under surface is white and fully haired almost to the base; the white hairs are shorter medially and longer laterally but viewed from the dorsal surface are inconspicuous. The upper face has the same brownish color as the back, with the terminal one-third black; in the more southerly portions of its range, however, the black encroaches upon the basal portions to a varying degree, the tail upon occasion being entirely black dorsally. I have examined a single specimen (no. 1295, B. C. Prov. Mus.) from Hardy Bay, Vancouver Island, British Columbia, in which also the underside of the tail was heavily pigmented.

THE SKIN GLANDS

With the exception of some of the subtropical representatives, the members of the genus *Odocoileus* all possess four specialized skin glands: The preorbital glands, the tarsal glands, the metatarsal glands and the interdigital glands.

Preorbital Gland

This is a simple, sac-like ectodermal "gland" situated just anterior to the internal canthus of the eye and accomodated by a pit in the lacrimal bone. The external opening is an oblique slit extending ventrally and anteriorly from the part of the eye named. The opening varies in length with the age, sex and race of the animal, as also does the size of the gland. The gland is largest in *O. h. hemionus* where the external orifice may be 30 millimeters long and the sac 23 millimeters deep. It is smaller in *O. h. columbianus* and least developed in the *Odocoileus virginianus* group. In some members of the latter species the gland is almost wanting.

In gross structure the skin of the sac is thinner than that of the surrounding regions and differs from the latter also in being of a clear white color and devoid of hairs.

Minute structure.—Weber (1888:540) describes the preorbital gland of *Cephalophus pygmaeus* as a mixed gland containing sebaceous and sudoriporous elements. Several other writers have described active secretion of the preorbital gland of artiodactyls. However, I have as yet been unable through microscopic examination to locate any glandular elements in the walls of the sac in *Odocoileus*.

Function.—The gland in this genus has no characteristic odor, and I have never seen it everted as it can be in representatives of many genera of antelopes. There is often no trace of a secretion of any kind within the gland. However, I have rarely found a small quantity of dark brownish material resembling ear wax. Indication of its lack of active function lies in the frequent invasion of the gland by fleas and other external parasites.

Regarding the possible utility of the head glands of *Artiodactyla*, Ogilby (1840:9) has suggested that the scent deposited by them on objects of the environment serves to direct the animals during fogs and

storms. Pocock (1910:975) suggests a sexual significance which he concludes from the greater size of the gland in the adult and the apparently increased activity in the breeding season. However, the gland is seemingly vestigial in *Odocoileus* and it is highly probable that it has ceased to be of vital importance to the animals of this genus.

Tarsal Gland

Externally the site of this gland is marked by a tuft of long coarse hairs on the median side of the tarsal joint. In *O. h. hemionus* and *O. h. columbianus* these hairs are usually of the same color terminally as are those of the surrounding regions; occasionally they are lighter in color. However, in these two races the basal one-half to two-thirds of the hairs on the tarsal gland is dark fuscous, very much darker than the corresponding parts of the hair on the surrounding areas. In *O. virginianus*, on the other hand, the tuft is usually light colored or white and lacks the dark bases of the hairs. In all races examined, of both species, there is usually a small patch of somewhat shorter, coarser hairs, reddish brown throughout, situated at the distal end of the gland. These dark hairs mark the site of the most actively secreting portion of the gland.

Minute structure.—The gland consists of a thickened area of the skin characterized by the great enlargement of the sebaceous and sudoriporous glands. The sebaceous glands, however, present the greatest enlargement and comprise the bulk of the secreting elements.

Function.—The tarsal gland secretes an oily material with a pronounced ammoniacal smell. The gland, at least in the male, seems to have some connection with the sexual cycle of the animal. In common with the other leg glands it becomes markedly more active during the breeding season, and at this time I have observed the bucks deliberately urinating on the tarsal tufts. F. C. Clarke (ms. 1912) quotes Mr. J. C. Werner of Quincy, California, as stating that his captive does had this habit of urinating on the tarsal tufts during and just prior to the period of sexual activity. Possibly the ammoniacal smell of the gland results from the urine rather than the secretion of the tarsal gland itself.

Metatarsal Gland

A tuft of long hairs on the outer side of the metatarsus in both sexes marks the position of this gland. In *O. hemionus* the tuft is more kinky and darker at the base than hair of the surrounding areas. In *O. virginianus* the hair on the central part of the gland is white throughout. The size and position of the gland varies considerably within the genus. In *O. h. hemionus* it averages 125 (75–150) millimeters in length and extends distally to a point 10 to 20 millimeters beyond the mid-point of the metatarsus. In *O. h. columbianus* the gland averages 51 (25–84) millimeters in length and has the same relative position on the metatarsus. In these two races, as in all others of *O. hemionus*, the metatarsal gland is situated largely, or entirely, above the mid-point of the shank. In marked contrast, the gland of *O. virginianus* in specimens examined never exceeded 25 millimeters and was always situated below the midpoint of the shank and below the normal

distal point of extension of the gland of the other species. In some specimens the gland has been reported as absent altogether.

Gross structure.—The metatarsal gland consists of an elongated elliptical area of glandular tissue marked externally by a similarly outlined tuft of long hairs. In the center of this, running the length of the gland, is an elevated horny ridge, usually black in color and devoid of hairs.

Minute structure.—The glandular tissue is composed for the most part of greatly enlarged, coiled tubular, sudoriporous glands. There is also a slight increase in the number and size of the sebaceous glands in this area. The central portion consists of a thickening of the epidermis to approximately 30 times that of the skin elsewhere. This thickened area of the epidermis consists of stratified layers of corneus tissue which, remaining adherent to one another, produce the externally visible black ridge. This portion of the gland is devoid of glandular elements and is subject to continuous excoriation.

Function.—The metatarsal gland secretes an oily substance with a pungent musky odor.

Pocock (1910:974) suggests that these glands serve to mark the resting spots used by the animals. They are most actively secreting, in the male sex at least, during the period of sexual excitement, but the increased activity of all the skin glands at this time may be only a concomitant of the incidental excitement and increased metabolic rate of the animal.

Interdigital Gland

Among deer having pedal glands, *Odocoileus* appears to be unique in possessing highly developed interdigital glands on the fore feet in addition to those on the hind feet. I have found no mention of their presence in the South American genera *Blastoceros* and *Hippocamelus*. In none of the races of *O. hemionus* is there any external indication of the presence of the gland other than its opening. However, in all the members examined of the species *O. virginianus* the region immediately surrounding the external orifice of the gland bears white hair in contrast to the brown hair of the remaining portions of the foot.

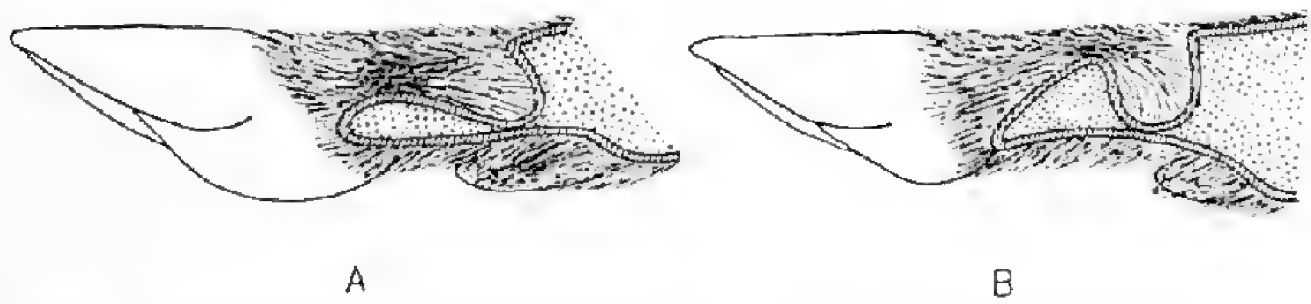


Fig. 55. Sagittal sections of, (A) fore foot, and (B) hind foot of an adult male *Odocoileus hemionus columbianus*, no. 70211, from 8 miles northwest of Cloverdale, Mendocino County, California, to show interdigital glands. x ½.

Gross structure.—In both fore and hind feet the interdigital gland consists of a simple sac-like invagination of skin from the dorsal surface between the two main digits in the region of the proximal phalanges. It opens on the dorsal surface of the foot through a wide orifice. The sac is lined with thin white skin, the surface of which is marked by conspicuous papillae. From the summit of each of these

springs a single long hair that projects from the opening of the gland and serves to conduct the secretion between the hoofs.

Minute structure.—I have found the glandular elements to consist for the most part of greatly enlarged sudoriporous glands; each gland is roughly circular in cross section and enclosed in a thin sac of connective tissue. The sebaceous glands are also somewhat enlarged but not to the same degree as are the tubular members.

Function.—The interdigital gland is actively secreting at all seasons, and the interungual ligament is constantly moistened by its oily secretion.

Owen suggested that the secretion serves to lubricate the hoofs and prevent these from cracking. This idea might be objected to, because the secretion more readily reaches the medial portion of the hoof than it does the parts subjected to greatest wear. I have thought a more probable use is to scent the tracks of the animals, enabling members of the species to find each other or to aid an individual in retracing its own steps as a doe might do in returning to her hidden fawn.

ANTLERS

The possession of deciduous frontal antlers by the males of all genera of the Cervidae, *Moschus* and *Hydropotes* excepted, is a striking family feature. Although these structures display much age and individual variation, the nature of this is somewhat limited and the adult antlers are characteristic in pattern, at least for each genus and often for individual species.

Garrod (1877:15) first suggested that antlers branched according to definite laws. His concept of the typical antler was that of a dichotomously branching beam with a basal brow tine. Brooke (1878: 377), in his excellent paper on the homologies between the branches of the antlers of the Cervidae, accepted this principle and presented what appears to be conclusive evidence that the brow tine also is an equal participant in this dichotomous branching. My own examination of antlers leads me to regard the homologies indicated by these writers as sound. In this paper I have adopted Pocock's (1933) antler nomenclature, though with slight modification which better adapts it to *Odocoileus*. (Fig. 56.)

b Base of the antler between pedicel on the frontal bone and the origin of a^1 and p^1; represents the bud of the growing antler before the rudiments of these branches appear.

a^1 Proximal, or first, anterior branch; equals brow tine, subbasal snag, basal snag, or Augenspross.

p^1 Proximal, or first, posterior branch.

a^2 Anterior branch of p^1; equals trez tine or Mittelspross; the anterior terminal branch of *Odocoileus*.

p^2 Posterior branch of p^1; equals entire posterior terminal branch of *Odocoileus*.

a^3 Anterior branch of p^2.

p^3 Posterior branch of p^2.

The antlers undergo two very distinct phases of growth. Each year the individual antler grows from a simple, unbranched bud into

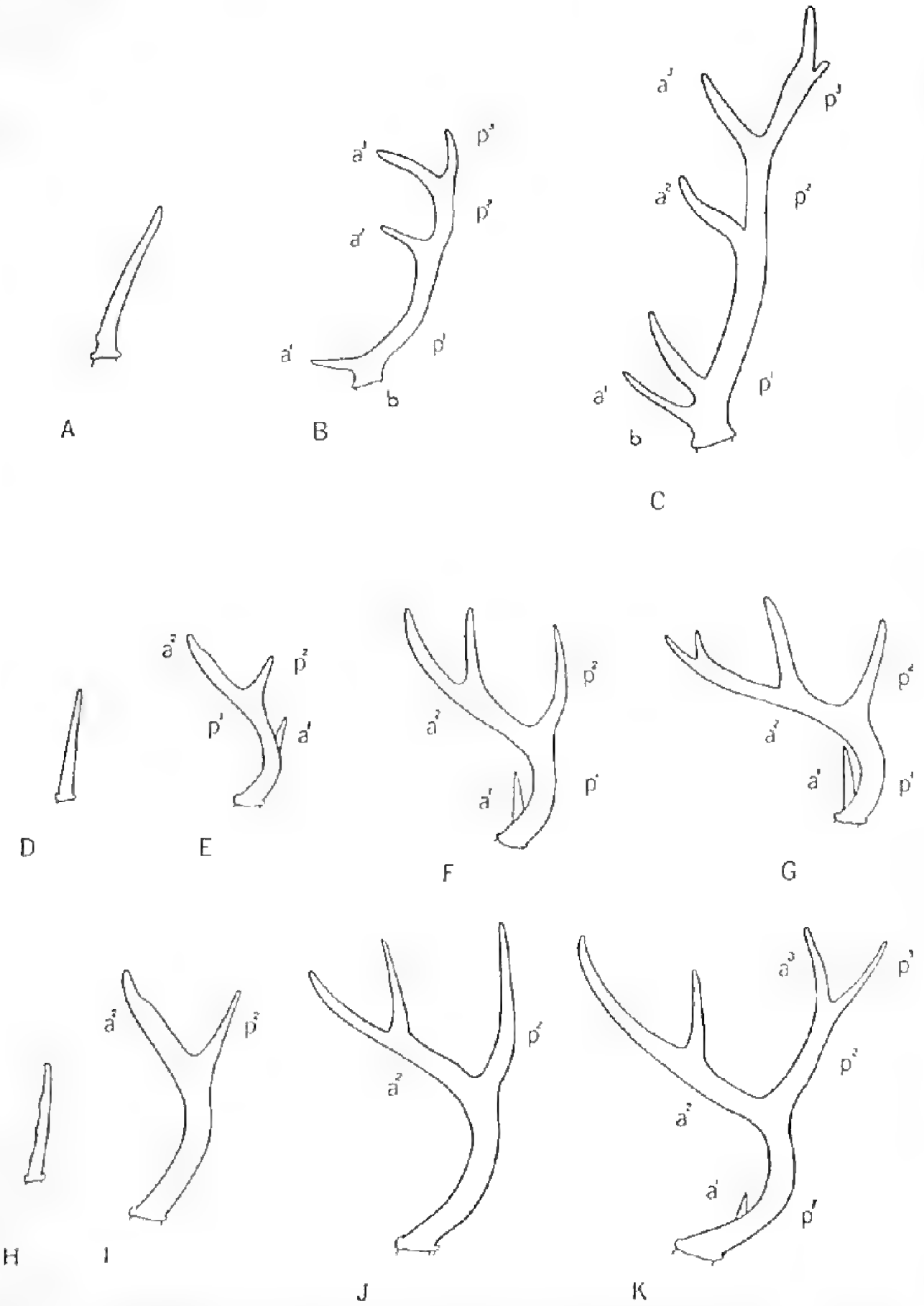


FIG. 56. Diagrams to show homology of antler tines in *Cervus nannodes*, *Odocoileus virginianus*, and *Odocoileus hemionus columbianus*: A. *Cervus* first year; B. *Cervus* young adult; C. *Cervus* mature adult; D. *O. virginianus* first year; E. *O. virginianus* second year; F. *O. virginianus* third year; G. *O. virginianus* adult; H. *O. h. columbianus* first year; I. *O. h. columbianus* second year; J. *O. h. columbianus* third year; K. *O. h. columbianus* mature adult.

the mature antler of greater or less complexity. From adolescence to an age of physical and sexual optimum the antlers under normal conditions increase in complexity annually. In *Odocoileus* the growth of an individual antler by a fully adult animal does not recapitulate the course of the history of the antler in its annual changes in size and form. In the development of an adult antler the first forking separates a^1 and p^1; but in the adult antlers of some races and the sub-adult antlers of all races the brow tine is usually abortive. In the "forked horn" condition, therefore, the beam of the antler is b-+-p^1 and forks are a^2 and p^2. A similar condition exists in the normal three-point antler of *O. h. columbianus*. Figure 56 will illustrate the homologies of the antler points in this genus and *Cervus*.

Antler types.—Within the genus *Odocoileus* there are two distinct types of antler, namely, the white-tail type with suppressed dichotomy, and the dichotomous, or mule deer type. The so-called white-tail type consists in the final adult form of a single beam which arises from the frontal pedicel and diverges slightly laterad as it sweeps backward and upward in an even curve; a short distance above the base each antler gives rise, on the median side, to a long, dorsomedially directed sub-basal snag (a^1). Dorsal to the point of origin of this prong the beam (p^1) diverges from the central sagittal plane of the skull more rapidly, and shortly gives rise to a long dorsally directed prong (p^2); the beam (a^2) then curves abruptly forward and inward, giving rise as it does so to one or more prongs on its dorsal surface. In this type of antler the sub-basal snag is usually compressed lateromedially so as to be elliptical in transverse section.

The dichotomous type characteristic of *O. hemionus* differs from the former type in that the main beam curves evenly away from the pedicel without any marked change in direction at the point of origin of the sub-basal snag. The snag itself is short rather than long, circular rather than elliptical in cross section, and directed dorsally rather than dorsomedially. The main beam (p^1) forks evenly giving rise to an anterior (a^2) and a posterior (p^2) secondary beam, each of which forks once again.

The differences described are readily discernible in the adult antlers, but the modifications of these basal types are endless; either the anterior or posterior beams, or both, may neglect to fork, or there may be a superabundance of prongs which mask the basic structural type of the antler. Then again the sub-adult antlers of either type show great superficial resemblance to that of the other. Nevertheless, except in the first antlers of young animals, there are certain basic features which distinguish the two kinds. These are:

1. In the white-tailed deer, the basal snag is first developed on the two-point antler, whereas in *O. h. hemionus* with the dichotomous type of antler the snag is not developed before the three-point antler of immaturity and is never present on the two-point antler of immature animals; it may, however, be present on the two-point antler of senile individuals.

2. Where present, the sub-basal snag is directed dorsally in the mule deer type of antler and medially as well as dorsally in the white-tail type.

O. h. sitkensis is the sole member of the *hemionus* Rassenkreis in which the antlers are difficult to distinguish from those of the white-tail type. In this race only a relatively small proportion of the population ever develops the adult dichotomous type of antler, and, furthermore, there is an amazing similarity between the three-point antler of this race and those of the white-tailed deer.

Antler Succession

Three to three and one-half months after birth a bulge appears on each frontal bone dorsal and immediately posterior to the post-orbital bar. The frontal protuberances grow rapidly outward from the cranium carrying with them a covering of skin liberally supplied with normal hair. By the time winter arrives the budding antlers project an inch or two above the forehead of the young buck. At this stage the frontal growths represent not only the pedicel, but also the base of what, during the following summer, will develop into the first set of antlers. At about 18 months of age the deer strips the velvet from his first pair of antlers, which may be simple spikes or small forks depending on the race and to a less extent on the vigor of the individual. Occasionally, and only in certain races, these first antlers may bear three points each. Regardless of the number of points, these antlers are characterized by slight lateral divergence; some are almost parallel. In the period from January to March the antlers are shed, and the growth of the second set commences.

Measurement of what may be regarded as a fairly average life series of antlers for *O. h. columbianus* are given in the accompanying table. These were obtained through the courtesy of R. O. Rompont of Ukiah, California, from the entire series of antlers grown by a buck

TABLE C

Measurements of Antlers Developed Throughout Life by a Male Coast Deer (*O. h. columbianus*)

Year	Number of antler set	Number of points	Basal circumference of left antler in millimeters	Length of left antler in millimeters
1917	1	1 : : 1	45	170
1918	2	2 : : 2	53	270
1919	3	3 : : 3+1	71	352
1920	4	3 : : 3	70	408
1921	5	3^1 : : 3^1	76	443
1922	6	3^1 : : 3^1	80	460
1923	7	3^1 : : 3^1	93	478
1924	8	4^2 : : 2	108	460
1925	9	4^2 : : 4^1	90	475
1926	10	3^1 : : 4^1	95	466
1927	11	4^2 : : 4^1	100	502
1928	12	3 : : 2+1	101	473
1929	13	4+1 : : 4+1	98	485
1930	14	2+2 : : 2+1	98	512
1931	15	3^2 : : 3^2	102	495
1932	16	2^1+2 : : 2^1+2	103	466

kept captive by him throughout its lifetime. In this table the measurement of basal circumference is that of the left antler approximately

one inch above the burr; length of antler is measured around the curve outside, from the burr to the tip of the most ventral prong on the anterior secondary branch. In the number of points, the indices denote the number of sub-basal snags present on the antler. A number after the + sign denotes the number of points present above the brow prong but not included in the normal adult dichotomous pattern. Thus $4^1+2::4^1+3$ is a normal adult antler with 4 main crown points and a sub-basal snag on each antler and also 2 extra points on the left side and three on the right side; therefore, total of points is 7::8 equals 15.

From this table it may be seen that *O. h. columbianus* can be considered normally to have spike antlers the first year; forked antlers the second, and three point antlers the third year. In subsequent years the number of points is not predictable. In many localities, for example on the coast of southern British Columbia, many of the largest bucks never develop better than three-point antlers and at some time in advanced age generally grow large single forked antlers. These large deer with forked antlers, in the parlance of some hunters, are "Pacific Bucks."

Gross Antler Structure

The antler consists of two types of bone. The mature antler has a sheath of compact bone (substantia compacta) 7 to 10 millimeters in thickness, completely surrounding it throughout its length and becoming thinner toward the tips of the tines. Except at the base the core of the antler consists of spongy bone (substantia spongiosa). The base of the antler and the part extending for a short distance above the frontal pedicel is entirely compact bone, and plays an important role in the shedding of the antler. Externally the dorsal limit of this disc of compact bone is marked by the presence of an exostatic ring, the burr or corona.

In young deer the antlers are comparatively smooth, but with increasing age of the animal each succeeding pair of antlers becomes progressively rougher at the base; those of a very old buck are thickly studded with osseous protuberances from the base nearly, if not quite, to the primary fork.

The Velvet

The velvet which covers the growing antler develops as an outgrowth of the skin surrounding the pedicel. After the antler is shed, a thin sheet of this skin is regenerated from the border of the "wound" and in two or three days' time has completely covered it. In this process the stratum lucidum grows faster than the stratum Malpigii and is the first completely to cover the wound (Macewen, 1923). This first velvet is true skin, not scar tissue, and as such consists of the three layers characteristic of vertebrate skin: an outer epidermal layer, a median dermal layer and an inner fibrous layer. It contains such normal skin structures as hair follicles and sebaceous glands, but lacks sudoriporous glands (Gadow, 1902:210). The corium and fibrous layer are liberally supplied with blood vessels, originating from the temporal artery (Macewen, 1920:11), and are innervated by branches of the trigeminal and facial nerves (Gadow, 1902:211). In the growing antler the fibrous layer of the velvet gradually merges with the undifferentiated layer of connective tissue lying immediately beneath it.

Contrary to the statement made by Gadow (*op. cit.*: 210) neither Macewen (1920) nor Noback and Modell (1930) were able to distinguish a separate periosteum between the velvet and the bone of the antler, but the last three authors describe the velvet as lying directly upon the developing bone.

The hairs produced by the velvet are fine, soft and of a uniform brown color. Each of these features differentiates them from the hairs upon the rest of the head region.

There has been considerable speculation as to the function of the velvet. Owing to its highly sensitive nature it probably acts as a potent protective device to the developing antler. Then too, its blood supply, while uniting slightly, if at all, with that of the interior of the antler, serves to produce warmth and to supply the requisite ossific pabulum, at least to the outer portions of the antler. Macewen (1923:91), in an address before the International Society of Surgery, makes the following statement regarding the velvet: "* * * the antlers, through the velvet, have a periodic reflex influence on the function of the testes. * * * If, however, the velvet is to serve the retardative function over the reproductive organs, then it must be shed annually and grown afresh." This statement seems to be without the foundation of fact, and to be based on faulty reasoning, for the coincidence of the growth period of the antler (and the velvet) with the period of minimal testicular activity hardly warrants the endocrine significance implied of the velvet by Macewen. Rather, in the light of modern knowledge, the reverse relation would be the more logical one.

Growth of the Antler

The exact process of bone formation in the antler was long a disputed question. Among others Müller (1825), Gegenbaur (1867) and Gadow (1902) maintained that the antler was preformed in cartilage; but the work of Robin and Herrmann (1882) and Noback and Modell (1930) gave basis for believing that it developed as a membrane bone. In 1931, Noback and Modell, in a second paper on the subject, showed fairly conclusively that while there is a substance closely resembling cartilage in general appearance, it is not true cartilage, but a fibrillar network developing from an undifferentiated connective tissue cap and undergoing direct bone formation in its transformation to the final form of the adult antler. Ossification takes place from the periphery basally, with the result that at any given stage of growth the ossified end is in the shape of a crater. The antler is laid down in its final diameter and except in the region of the corona does not increase in diameter, once preliminary ossification is accomplished.

With approaching maturity of the antler, the corona and base increase in size probably by deposition of bone around the superficial vessels. The development of the coronal processes about these blood vessels materially reduces their flow of blood. At this time, as a result of the action of some unknown stimulus, the deer strips the velvet from the antlers. It has been repeatedly suggested that the enlargement of the corona and diminution of the blood supply to the velvet is the motivating stimulus for this removal. However, the amount of bleeding that accompanies the early stages of stripping the velvet would indicate that the blood flow was at least not entirely cut off. At the

same time that the velvet is being shed, continuation of the process of ossification at the level of the corona slowly constricts the lumina of the vessels there and finally entirely closes them, leaving a dense, ivory-like disc of bone. Internal ossification proceeds for a month or more after the velvet is shed, adding 25 per cent to the weight of the antler.

Fully formed, the antler is a hard, smooth weapon of offense and defense, but it persists as such for only a short time. The actual duration of this persistence depends upon the age and physical condition of the animal. The younger animals carry the antlers until later in the spring than the older ones; and animals in poor health generally shed earlier in the season (Skinner, 1921:172).

Shedding of the Antler

The antler, from the time of shutting off of the blood supply, is a dead structure; its shedding is analogous to the necrosis and sloughing known to occur in other animal tissues as a result of injury or disease.

Preparatory to shedding of the antler the frontal bone and pedicel become highly vascular. Ischemic necrosis results in the breaking down of an arc of bone between the pedicel and the base of the antler, and a necrotic, peripheral line appears externally just below the corona and extends across the whole area of the pedicel. The antler finally falls off, of its own weight or as a result of accidental contact with external objects, leaving a naked cavity on the tip of the frontal pedicel.

Infrequently, possibly as a result of injury to the frontal pedicel, or disease of the frontal bone, this separation does not take place normally, but the antler, when shed, takes with it a greater or smaller part of the frontal bone. In a specimen of *O. h. hemionus* examined (M. V. Z. no. 59744) the left antler has been shed more or less normally, but the right one has a piece of the frontal bone approximately one inch long and one and one-half inches in width attached to its median side. Holding (1897:189) cites a somewhat similar instance in the genus *Dama*, in which the amount of the frontal bone removed increased with each succeeding set of antlers for three successive years.

THE ANTLERS AS SECONDARY SEXUAL CHARACTERS

The antlers of deer are secondary sexual structures and as such are governed largely by the hormone secretion of the gonads; in consequence any destruction of these glands might be expected to have its effect on the antlers of the individual.

Neglecting the appearance of normal antlers in sexually perfect males, antler phenomena seem to fall into the following natural classes:

1. Bucks with normal antlers but impaired gonads.
2. Bucks with abnormal antlers.
3. Bucks without antlers.
4. Does with imperfect, non-deciduous antlers.
5. Apparent does with perfect antlers.

1. Bucks with normal antlers but impaired gonads.—Fowler (1894), Rörig (1899), and many other writers, have maintained that injury to, or removal of, one testis was accompanied by degeneration

of the antler on the opposite side; in other words, that there was a transverse correlation between the testes and the antlers. Experiments performed by Gaskoin (1856:150) and Zawadowsky (1926:18) on the Fallow Deer (*Dama dama*) and the Red Deer (*Cervus elaphus*) definitely prove that such is not the case, and that apart from suffering some immediate impairment in their general health, and consequent reduction in size of the first pair of antlers produced thereafter, the animals unilaterally castrated produced antlers that were normal in every respect.

2. Bucks with abnormal antlers.—The abnormalities treated under this heading seem to fall into two natural groups:

A. Antlers with velvet persistent.
B. Deformed antlers, histologically perfect, shedding the velvet, and otherwise going through the normal growth cycle.

Those antlers falling in group A are, so far as is known, always produced by a castrated animal and owe their distortion and failure to shed the velvet to the removal or atrophy of the testes. This type of injury with accompanying antler malformation is too common in nature to warrant citation of definite cases.

The result of castration, as reflected in the antler growth of deer, depends upon the time of life at which the operation is performed. From the results of Zawadowsky's experiment I now tentatively advance the following generalizations as of application to all cervids.

(a) If a fawn be castrated during the first few weeks of its life, no antlers will develop.

(b) If the castration be performed several months after birth, the antlers will develop but will be short, knob-like, persistent and with persistent velvet.

(c) If an adult buck has the testes removed when the antlers are in the first one-half to two-thirds of their growth, they will not be shed and will be permanently covered with velvet.

(d) If an adult buck be castrated when the antlers are in the last one-half to two-thirds of their growth, the antlers will be shed within a few weeks and replaced by a permanent set permanently covered with velvet. The same result is obtained with castration after the velvet has been stripped from the antlers.

It must be noted that the above are generalizations; I have encountered a few seeming exceptions to most of these "rules."

The forms assumed by the antlers of castrated males are diverse. They may be long, unbranching prongs; they may be of the more or less symmetrical "pineapple" type, consisting of large numbers of short exostoses radiating from a point close to the normal position of the corona; or they may more closely approximate the normal antler.

Deformed antlers which undergo the normal annual growth cycle (falling in group B), as far as can be determined, owe their ultimate condition either to injuries to the growing antler, or to a diseased condition of the frontal pedicel. In the first instance the antler will only possess its abnormal form for a single season, whereas if the second cause is the operative one, it may continue to develop abnormally at least as long as the pathologic condition persists.

Injuries to the developing antler may take place in the early formative period, in which event the antler may be greatly deformed, or not at all deformed, depending on the extent of the injury. D. D. McLean of the California Fish and Game Commission has removed a small portion from the very tip of the growing antler without producing any visible modification in the mature structure. On the other hand, a captive individual at the University of California that repeatedly injured its antlers throughout the growing period, developed long unbranched prongs with some basal irregularities. If the injury takes place in the later stages of the development, after the antler has attained more or less of the mature form, the result is generally a simple fracture. In this condition the broken portion generally knits at a distorted angle, and the site of the fracture is indicated by a thick ring of osseous material.

Seton (1929:374) and Clarke (1916:120) have claimed that injuries to the body can produce abnormalities in the antler structure, and furthermore, that the malformed antler is nearly always on the same side as the injury. Considering the fact that many bucks with malformed antlers have no visible sign of a recent injury, and also that not all bucks showing signs of injury have distorted antlers, one is forced to doubt the cogency of these inferences. Furthermore, in no case cited as an example by these authors is it impossible that the same factor that produced the bodily injury could not have at the same time injured the antler.

Malformation in which large numbers of points are borne on otherwise normal antlers have as yet no known explanation.

3. Bucks without antlers.—Cases of this type are infrequently reported, probably because in most parts of North America such animals would escape detection by being mistaken for does which in most places are protected by the game laws. In the few instances of this kind in European genera analyzed by Rörig (1899:382) it was found that some of the bucks were sexually normal and that others had abnormal genitalia.

4. Does with imperfect and non-deciduous antlers.—A specimen of *O. h. hemionus* (M. V. Z. no. 35326) falls into this category. The animal, besides having persistent velvet, has the antlers greatly distorted. Both antlers exhibit four irregular points arising from the basal region. Measurements are as follows: height of left antler, 180 mm.; height of right antler, 340 mm.; circumference of left antler at base, 88 mm.; circumference of right antler at base, 161 mm. According to Dixon (1927:289) who examined the fresh skin of the specimen, the external genitalia were normal, except that the mammae were small and about the same size as those of a buck. It is significant that all specimens of this class examined lacked the corona.

In spite of the relatively frequent occurrence of antlered does in western North America, no specimens of such have ever been subjected to a detailed anatomical examination to determine the condition of the sex organs.

5. Does with perfect antlers.—There are no published accounts of does with perfect antlers being fertile. The antlers of 4 such animals in the collection of the Museum of Vertebrate Zoology are in each case

typical for the genus and just such as one would expect to be exhibited by a male of 2 or 3 years of age. Two of the specimens have normal forked antlers; a third has forked antlers and aberrant subbasal snags projecting anteriorly from the burr; and the fourth has typical three-point antlers.

I am indebted to Mr. D. D. McLean for information concerning a captive deer in his possession of the kind in question. With regard to external genitalia the animal is apparently a female. It had spike antlers when captured. These were shed at the normal time and were replaced by a pair of forked antlers. This set of antlers has followed the normal growth-cycle, and the velvet was shed in identically the same fashion as would be expected in a male deer of the same race. It is significant that during the rutting period this "doe" developed a swollen neck, a belligerent disposition and other characteristics which males ordinarily display at the same period of the year. This deer vigorously attacked a buck in the same enclosure and repeatedly attempted copulation with another doe.

In interpreting the data presented above it is convenient to recognize 3 periods in the growth of an antler:

1. An organogenic period occurring fairly early in life and possibly coinciding with the development of the antler pedicel. Castration prior to this period suppresses antler development.

2. Early developmental period, persisting through the first one-half to two-thirds of the growth period.

3. Final developmental period, during which the process of ossification is completed, the burr is enlarged and the velvet shed.

It would further seem probable that:

1. A factor or factors (not necessarily in the genetic sense) for antler development is present in both sexes of the Cervidae with the exception of the genera *Moschus* and *Hydropotes* in which both sexes lack antlers.

2. There is an additional factor or factors bringing about maturing and shedding of the antlers.

3. Early castration or the presence of the female sex hormone alone in most instances suppresses the first factor.

4. Late castration removes or suppresses the second factor but does not interfere with the first factor.

5. Degeneration of the female gonads with destruction of the endocrine producing portion removes the suppressive influence acting on the first factor.

6. Presence of the male gonads is essential for the action of the second factor.

TOOTH SUCCESSION

The upper premolars, the third and fourth lower premolars, and the entire incisor series erupt before birth. The second lower premolar may erupt at the same time as the rest of the series, but often it does not do so until a later date. With the eruption of the incisor series the three lateral members revolve through an arc of approximately 90 degrees so that they come to have the adult orientation in the row.

During the first two months of postnatal life the members of the deciduous series complete their development and become more heavily pigmented (Fig. 57). Before the age of 3½ months is reached the first

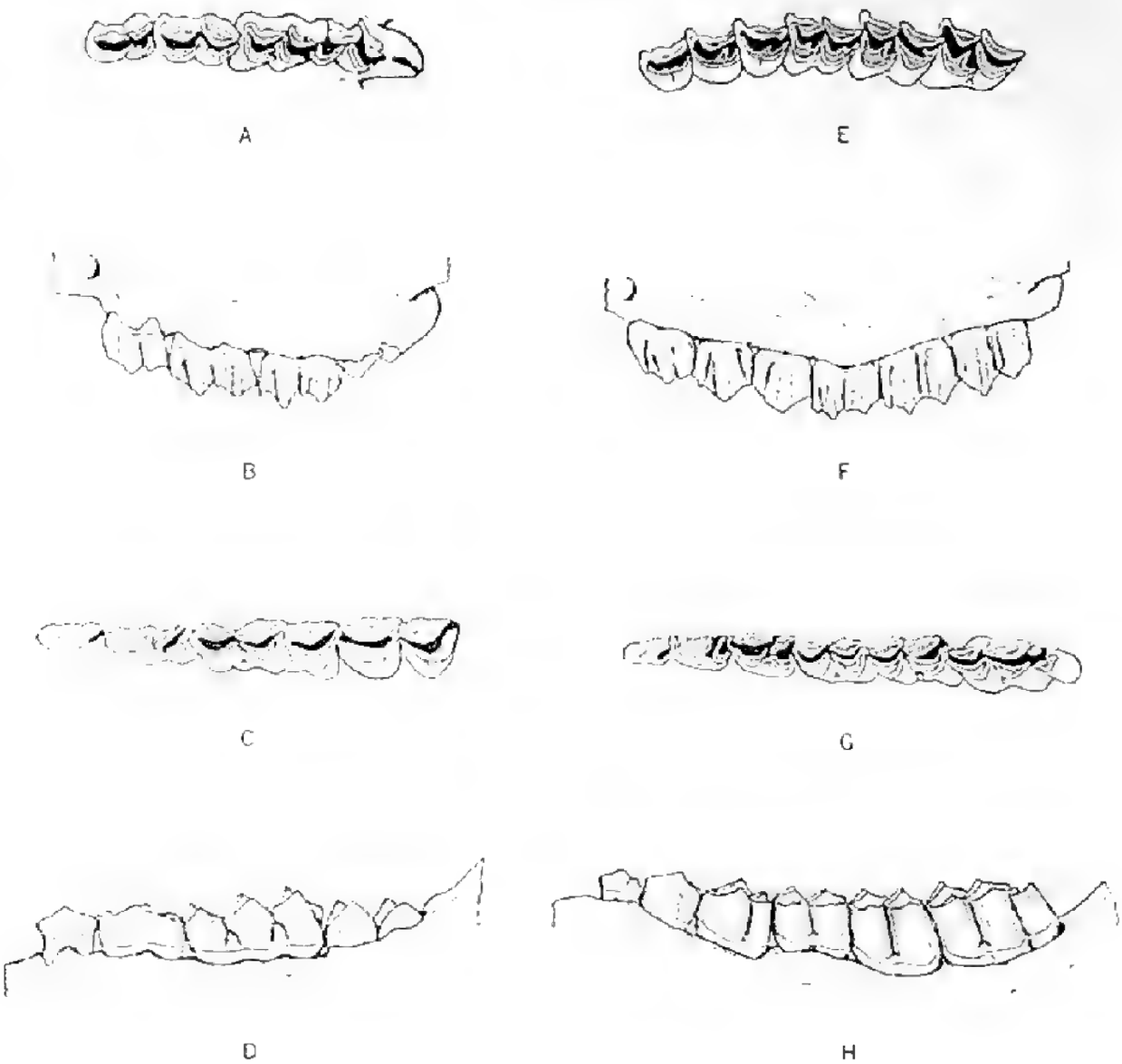


FIG. 57. Teeth of *Odocoilcus hemionus columbianus*. A, B, C and D, one day old female fawn, no. 12060, Mus. Vert. Zool., Alberni, Vancouver Island, British Columbia, June 11, 1910, x 13/20. E, F, G and H, adult male, no. 424, collection of writer, North Vancouver, British Columbia, x ½. A and E, occlusal view of left upper molar series; B and F, lateral view, left upper molar series; C and G, occlusal view, left lower molar series; D and H, lateral view, left lower molar series.

upper molar has taken its place in the functional tooth row and is closely followed by the first lower molar. Throughout the period of development of the two remaining superior molars the tooth-bearing portion of the skull elongates, with the result that each tooth of the series commences its development opposite the posteriormost point on the palatinomaxillary suture. Similarly, lengthening of the corpus (horizontal ramus) of the mandible results in each lower molar erupting at the angle made by the vertical ramus with the corpus. The second molars are the next to appear in the functional series. This takes place coincidently in the upper and lower jaws, and at the same time the Anlagen of the third upper and lower molars appear. Also at the age of one year the first incisor is shed and replaced by its permanent successor. The new incisor during the early stages of its development lies with its transverse axis dorsoventrally, and in the process of eruption its anterior tip lifts and carries out its deciduous precursor. This tooth rotates through an angle of 90 degrees, to take up its position in the incisor row. This series of events is characteristic of the development of all members of the incisor series, including the canine. The second incisor is replaced at the age of approximately 14 months, followed in quick succession by the third incisor and the canine; thus, at the age of 18 months, the deer usually has all of its permanent incisors. In this entire replacement never more than one tooth from each side of the row is erupted at one time; the first permanent incisor is completely developed and functional before the second deciduous incisor is shed, and so on throughout the process. Each permanent incisor is wider than its predecessor so that, except when the first incisor is shed, there is never any real hiatus in the tooth row.

At the age of 15 to 18 months the third molars erupt and take their places in the series of cheek teeth. At this time the dental formula is as follows: permanent incisors 0/3; permanent canines 0/1; deciduous premolars 3/3; molars 3/3.

Already at the age of 15 months the median root of the deciduous fourth premolar is being dissolved, and dissection reveals the primordium of the permanent fourth premolar, already partly calcified. Growth of this tooth is rapid and the replacement of the deciduous member takes place between the 18th and 20th months. At almost the same age the dorsal counterpart is shed and replaced by the corresponding member of the permanent dentition. As a general rule the order of replacement of the premolars is: premolar 4/4; premolar 3/3; premolar 2/; and premolar /2. However, there is some variation in this sequence. The replacement of the premolars completes the permanent dentition (Fig. 57). This occurs in *O. h. columbianus* at the age of approximately 24 or 25 months.

The material available indicates that the same general sequence is followed by *O. h. hemionus* and *O. h. californicus* and probably also by other members of the species.

DEFINITION OF MEASUREMENTS

Basilar length of Hensel.—Distance from anteriormost point on ventral lip of foramen magnum to anterior tip of premaxillae.

Nasal length.—Greatest distance from posteriormost point on posterior margin of nasal to posteriormost point on anterior margin of same bone.

Greatest width of nasals.—Greatest combined width of two nasals measured superior to antorbital vacuities.

Least width of nasals.—Least combined width of two nasals anywhere along union of maxillae and nasals.

Orbital width.—Least width of frontal region measured between frontolacrimal sutures on anterodorsal rims of orbits.

Zygomatic width.—Greatest width of skull at zygomata, measured posterior to post-orbital processes of jugals.

Mastoid width.—Distance across skull between points of contact of mastoids with paroccipital processes.

Maxillary width.—Greatest width of maxillary region, measured opposite posterior margin of first upper molar.

Palatal breadth.—Greatest width of palate measured between third upper molars.

Post-palatal width.—Least palatal width posterior to third upper molar.

Width of external nares.—Greatest internal width of external nares.

Elevation of rostrum.—Distance between anterior tip of premaxilla and plane upon which skull is resting on tips of paroccipital processes and second molars.

Length of external nares.—Greatest length of anterior narial opening measured diagonally from tip of premaxilla to union of nasal with maxilla or premaxilla on same side.

Upper molar series.—Greatest alveolar length of combined upper molars and premolars.

Lower molar series.—Greatest alveolar length of combined lower molars and premolars.

Diastema.—Least distance between posterior margin of alveolus of canine to anterior margin of alveolus of second lower premolar.

Additional Measurements Used in Study of Ontogeny of Cranium

Palatal length.—Gnathion to anteriormost point on posterior margin of palate.

Post-palatal length.—Anteriormost point on posterior margin of palate to most anterior point on inferior lip of foramen magnum.

Prealveolar length.—Least distance between alveolus of second upper premolar and gnathion.

Frontal length.—Distance on mid-line between bregma and anteriormost point on fronto-nasal suture.

Parietal length.—Combined length of parietal and interparietal measured along mid-line.

Temporal width.—Greatest width of brain case; in antlered skulls measured behind antlers.

Palatal width.—As measured between alveoli of second upper premolars.

Intermaxillary width.—Greatest external width of combined maxillae.

Least temporal width.—Measured above external auditory meatus, from zygomatic ridge on squamosal to its opposite.

Fronto-palatal depth.—Depth of skull measured from most posterior point on palate to summit of frontal elevation.

Palato-nasal depth.—Least distance on mid-line between fronto-nasal suture and palate.

Occipital depth.—Measured on mid-line between anterodorsal margin of supra-occipital and superior lip of foramen magnum, distance being taken in a straight line.

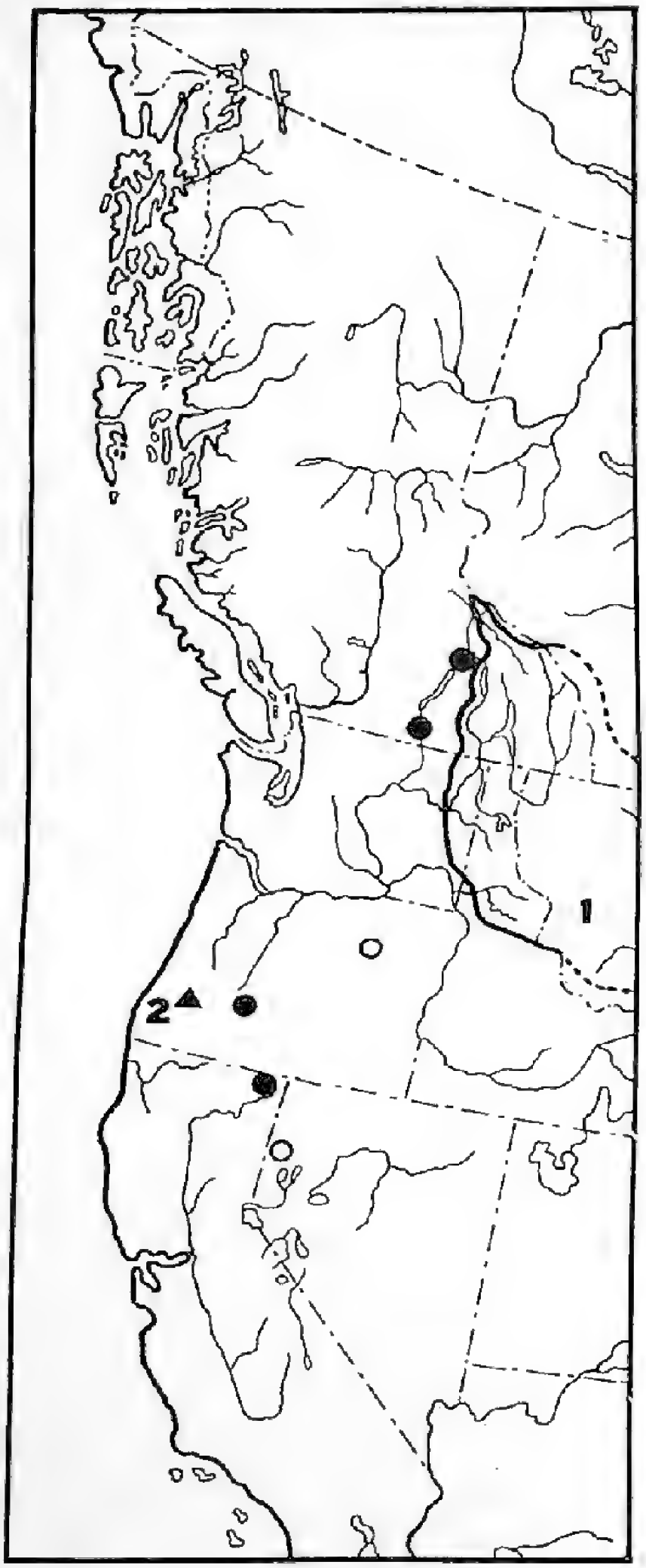


FIG. 58. Ranges of white-tailed deer (*Odocoileus virginianus*) in western North America.

1. Range of *O. v. ochrourus*.
   Solid circles indicate extralimital occurrences of *ochrourus* based on specimens.
   Open circles indicate extralimital occurrences of *ochrourus* not based on specimens.
   Broken line indicates hypothetical limit of range.
2. Solid triangle indicates present occurrences of *O. v. leucurus*.

ARTIFICIAL KEY TO ADULT MALES OF THE RACES OF ODOCOILEUS INHABITING THE PACIFIC COAST OF NORTH AMERICA

1 (4) Metatarsal gland with central hairs white; this gland generally less than 1 inch in length; tail long, broadest at base, without black on dorsal surface; lacrimal fossa very shallow. (2 or 3)

2 Dorsal surface of tail in winter pelage, gray; posterior margin of palate in line with posterior edge of M^3; range entirely in Oregon west of Cascades. *leucurus*

3. Dorsal surface of tail in winter, yellowish brown; posterior margin of palate markedly posterior to M^3; range east of Cascades. *ochrourus*

4 (1) Metatarsal gland with no white hairs and greater than 1 inch in length; tail short, entire tip black; lacrimal fossa deep. (5)

5 (6) Range confined to Cedros Island. *cerrosensis*

6 (5) Range not including Cedros Island. (7)

7 (8) Sublacrimal process of jugal less than 5 mm. in greatest width; width of Pm^2 not more than 9 mm. *sitkensis*

8 (7) Sublacrimal process of jugal greater than 5 mm. in greatest width; width of Pm^2 generally more than 9 mm.

9 (12) Upper tooth row less than 75 mm. (10)

10 (11) Posterior margin of vomer closely paralleling basispheuoid; palatal width less than 70% upper molar series; tail generally not naked ventrally for ½ length. *columbianus*

11 (10) Posterior margin of vomer diverging sharply from basisphenoid; palatal width greater than 70% upper molar series; tail generally naked ventrally for ½ length. *californicus*

12 (9) Upper tooth row greater than 75 mm. (13)

13 (22) Rump patch not divided by dark line extending from back to root of tail. (14)

14 (17) Diastema of lower jaw greater than 80% of lower tooth row. (15)

15 (16) Basilar length of Hensel less than 255 mm.; width of external nares 52% rather than 48% their length. *californicus*

16 (15) Basilar length of Hensel greater than 255 mm.; width of external nares 48% rather than 52% their length. *hemionus*

17 (14) Diastema of lower jaw generally less than 80% of lower molar series. (18)

18 (19) Range north of Colorado desert. *inyoensis*

19 (18) Range Colorado desert and south. (20)

20 (21) Width of Pm^2 not greater than 10 mm.; range confined to southern half of Lower California. *peninsulae*

21 (20) Width of Pm^2 12 mm. or greater; range not extending into southern half of Lower California. *eremicus*

22 (13) Dorsal surface of tail with more or less brown or black dividing rump patch. (23)

23 (28) Tail naked below for half its length. (24)

24 (25) Elevation of rostrum 42 mm. or greater. *peninsulae*

25 (24) Elevation of rostrum less than 42 mm. (26)

26 (27) Range San Diego County and southwards; palatal breadth usually greater than 65% alveolar length of upper molar series. *fuliginatus*

27 (26) Range north of San Diego County; palatal breadth usually greater than 65% alveolar length of upper molar series. *californicus*

28 (23) Tail not naked below for half its length. *columbianus*

SYNONYMY AND DIAGNOSIS OF THE GENUS ODOCOILEUS

Odocoileus Rafinesque, Atlantic Journ., 1, 1817:109; Eliot, Synop. Mamm. N. Amer., 1901:38; Pocock, Proc. Zool. Soc., 1912:780; Miller, U. S. Nat. Mus. Bull., 79, 1912:385; Lydekker, Cat. Ung. Mamm. Brit. Mus., 4, 1915:153; Miller, U. S. Nat. Mus. Bull. 128, 1924:484.

Cariacus "Lesson, Nouv. Tabl. Regne Anim., Mamm., 1842:173;"* Gray, Cat. Rum. Brit. Mus., 1872:82; Gray, Hand-list Edent. Thick-skinned and Rum. Mamm., Brit. Mus., 1873:155; Brooke, Proc. Zool. Soc., 1878:918.

Dama, Allen, Bull. Amer. Mus. Nat. Hist., 16, 1902:18 after Zimmermann.

Dorcelaphus "Gloger, Handbuch Naturgesch., 1841:140;" Lydekker, Deer of All Lands, 1898:248; Pocock, Proc. Zool. Soc., 1910:962.

Eucervus Gray, Ann. Mag. Nat. Hist., ser. 3, 18, 1866:338; Gray, Cat. Rum. Brit. Mus., 1872:85; Pocock, Proc. Zool. Soc., 1910:966.

Gymnotis Fitzinger, Sitzungsber. k. Ak. Wiss. Wein, 78, pt. 1, 1879:343.

Mazama, "H. Smith, Griffith's Animal Kingdom, 5, 1827:314."

Odocoelus Allen, Amer. Nat., 35, 1901:449.

Odontocoelus Elliot, Field Columb. Mus. Publ. Zool., 1904:70.

Diagnosis.—Lateral metacarpals with only distal ends persisting; vomer high and dividing nostrils posteriorly into two chambers; antlers present in male only; antlers large, with beam rising at marked angle to plane of face, and generally (when fully developed) dichotomously forked, with a sub-basal snag, and anterior prong of main fork more or less developed at expense of hind prong; main prongs with more or less secondary forking of either or both; face long and narrow; rhinarium well developed; ears variable as to size and amount of hairiness; tail long to moderate and with or without hairs below; coat uniformly colored; tarsal and usually metatarsal glands present; interdigital glands present on both fore and hind feet; lacrimal pits and preorbital glands small; two lacrimal ducts on rim of orbit; upper canines wanting; naviculo-cuboid of tarsus free from cuneiform; young spotted.

Range of genus from Alaska to Peru, Bolivia and northern Brazil.

SYSTEMATIC ACCOUNTS

Odocoileus virginianus ochrourus Bailey.

Northwestern White-tailed Deer

Odocoileus virginianus ochrourus Bailey, Proc. Biol. Soc. Wash., 45, 1932:43.

Cariacus leucurus, Gray, Hand List Edent., Thick-skinned and Rum. Mamm. Brit. Mus., 1873:155; Brooke, Proc. Zool. Soc., London, 1878:919.

Cariacus virginianus, Gosnell, Yearbook of British Columbia, 1911:308.

Cariacus Virginianus, Tyrrell, Proc. Canad. Inst., 1888:6.

Cervus leucurus Douglas, Zool. Journ., 4, 1829:330 (part); Richardson, Fauna Bor. Amer., 1829:258 (part); Baird, U. S. Pac. R. R. Exp. and Surveys, 8, 1857: 649 (part); Lord, Nat. in Vancouver Isl. and Brit. Col., 2, 1866:183.

* Citations enclosed in quotation marks are those which I have not been able to verify by myself examining the original works.

C[ervus]. leucurus, "Schinz, Syst. Verz., 1, 1844:381 (part)."
Mazama americana macrura, Lydekker, Deer of All Lands, 1898:257 (part).
Odocoileus leucurus, Brooks, Canad. Mag., 29, 1907:541.
Odocoileus virginianus, Clarke, Bur. Prov. Inform. Brit. Col., Bull. 17, 1910; Jewett, The Oregon Sportsman, 2, no. 8, 1914:5; Hall, Calif. Fish and Game, 13, 1927:238.
Odocoileus virginianus leucurus, Lydekker, Cat. Ung. Mamm. Brit. Mus., 4, 1915: 162 (part).
Odocoileus virginianus macrourus, Grinnell, Proc. Calif. Acad. Sci., 3, 1913:336; Brooks, Canad. Mag., 29, 1907:541; Taylor and Shaw, Occ. Papers Chas. R. Conner Mus., no. 2, 1929:30; Grinnell, Dixon and Linsdale, Univ. Calif. Publ. Zool., 35, 1930:574; Grinnell, Univ. Calif. Publ. Zool., 40, no. 2, 1933:208; Elliot, Field Columb. Mus. Zool. ser., 2, 1901:39 (part).
Odocoileus virginianus ochrurus, Bailey, Nature Mag., 21, no. 3, 1933:126; Sheldon, Santa Barbara Mus. Nat. Hist., Occ. Papers, no. 3, 1933:21.

Type.—Male, adult; skin and skull, no. 159353, U. S. Nat. Mus., Biol. Surv. Coll.; taken at Coolin, south end of Priest Lake, Idaho; Dec. 27, 1908; collected by Frank Lemmer; (Miscellaneous cat.) orig. no. 7483.

Range.—Northeastern California and northwestern Nevada northward through Oregon and Washington east of the Cascade Mountains to about 52 degrees north in southeastern British Columbia.

Coloration.—*O. v. ochrourus* exhibits a wide range of color variation. A single large male in fresh winter pelage from Yahk, B. C., is markedly darker than a female taken at the same place at almost the same time, and it is darker also than the specimens from Deschutes County, Oregon. However, the paleness of the Oregon skins, taken in January, is no doubt due in large part to fading.

Winter pelage.—Upper parts dark buffy gray with light bands on hairs near (14'c) Light Ochraceous Buff. The darkness or lightness of the general color tone of the dorsal surface is dependent upon the relative widths of the black hair tips and the subterminal light annulations. No marked dorsal dusky area; top of tail, edges of belly, and legs, from Light Ochraceous Buff to Cinnamon; anterior surfaces of hind legs usually darkened by dusky hair bases showing through; breast, and narrow line down brisket, dusky; males with brow patch dusky between antlers, becoming lighter anteriorly due to presence of long yellowish hair tips, and without anterior dark V; females with brow patch poorly defined, Light Ochraceous Buff to Tawny; ears gray outside, white inside, tip black; eyelids, three spots at base of rhinarium and two on sides of lower lip, Fuscous to Black; sides of nose and eye ring light gray; tip and lower surface of tail, entire belly, throat patch and lower lip, inside of legs to metapodial segment, white; white of belly extending anteriorly on chest to a point in front of axillae. Metatarsal glands short and with central hairs white; orifice of each interdigital gland marked by small patch of white hairs between and above hoofs; hairs of tarsal tuft white at least at base, but frequently with tips light brown.

Summer pelage.—Upperparts bright tawny or light bay; legs only slightly lighter, not yellowish as in *O. v. macrourus;* no real black on top of tail as in *macrourus* and *O. v. borealis* (Bailey, 1932:44).

External comparisons.—*O. v. ochrourus* can be distinguished from *leucurus* in any pelage by larger size and by yellowness of the tail, that

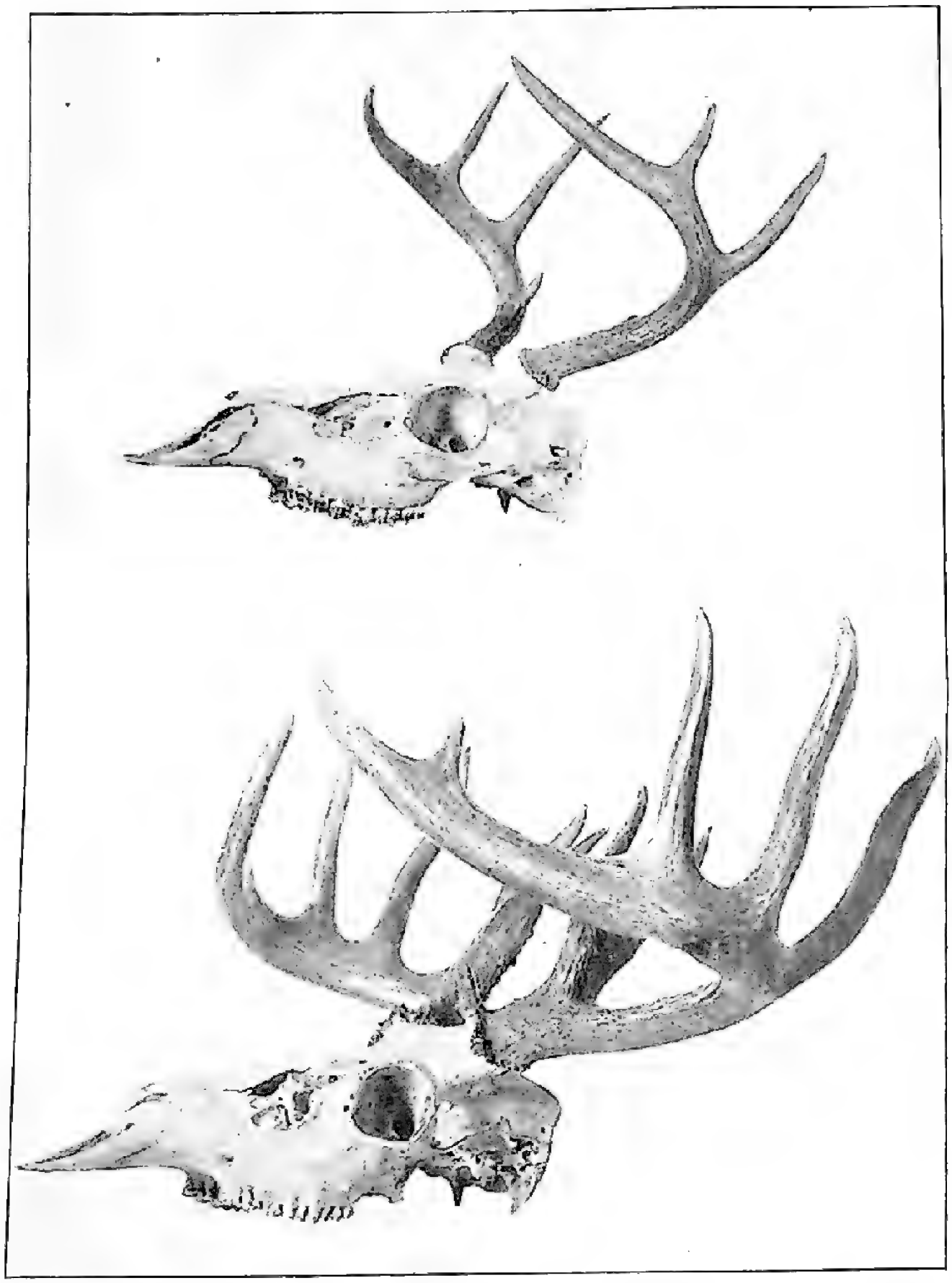


FIG. 59. Above, skull and antlers of *Odocoileus virginianus leucurus*, male, adult, no. 375, collection of S. G. Jewett, from Short Ranch, near Roseburg, Douglas County, Oregon. × slightly more than ½ natural size. Below, skull and antlers of *Odocoileus virginianus ochrourus*, male, adult, no. 10654, Nat. Mus. Canada, from Yahk, British Columbia. × ½.

of *leucurus* being in comparison grayish brown; *ochrourus* also has dorsal surface lighter in color; white of underparts more extensive, generally extending anteriorly at least as far as axillae.

Cranial comparisons.—Compared with *leucurus, ochrourus* has posterior margin of palate projecting markedly (17 mm.) posterior to caudal border of M^3 rather than on a plane with, or very slightly (2 mm.) posterior to, this point; skull larger in every measurement taken; first upper premolar (Pm^2) wider, averaging 11 mm. as opposed to 10 mm.; posterior nares terminating relatively as well as actually farther posteriorly; dorsal line of fronto-nasal region, anterior to frontal eminence, convex rather than straight. With skull on a flat surface that of *ochrourus* rests on the paroccipital processes and molars 2 and 3 whereas in *leucurus* molars 1 and 2 touch the supporting plane. In occipital region juveniles of *ochrourus* closely resemble adults of *leucurus* except that the condyles are smaller in *leucurus*.

Antlers.—The antlers of *O. v. ochrourus* are of typical white-tail type with p^1—a^2 forming the main beam of the antler (see Fig. 59). The typical antler of a fully adult animal exhibits a long, laterally flattened sub-basal snag (a^1) and four or more crown prongs, but as in all other races of the genus *Odocoileus* the departures from, and variations of, the typical condition are legion. The sub-basal snag is often double on one or both sides. The posterior crown prong (p^2) also is often branched at the tip; the incidence of this secondary forking, however, becomes progressively less on the more anterior tines.

Remarks.—Lacking material of *macrourus* for comparison I have accepted Bailey's (1932:43) arrangement. Specimens from Yahk, British Columbia, are near enough to the type locality to be regarded with safety as true *ochrourus*, and because specimens from the East Kootenay Tobacco Plains do not differ materially from Yahk material, I have referred all the white-tails of British Columbia to the race *ochrourus*.

Douglas mentions the species as being abundant everywhere in western Oregon at the time of his visit there. Probably, *ochrourus* has intergraded with the more westerly form, *leucurus* in western Oregon, within comparatively recent years. At present, however, the two races are separated by a wide area thought not to be inhabited by white-tail deer. The smaller size and structure of the skull of the specimens from Deschutes County shows approach to the conditions exhibited by *leucurus*.

O. v. ochrourus is most common in the Transition Life Zone, but it extends sparingly into the Upper Sonoran and Canadian zones. In the northern parts of its range the race, while preferring the dense growth of the river bottoms, where Black Poplar (*Populus trichocarpa*) is the dominant tree, also occurs in the Larch (*Larix occidentalis*)-Douglas Fir (*Pseudotsuga taxifolia*) association of the second bench above the rivers. In the spruce (*Picea engelmanni*) belt it is less common, but I have encountered it there occasionally on the western slope of the Rocky Mountains in the vicinity of Kootenay National Park, British Columbia. Farther south in the Transition and Upper Sonoran zones the white-tailed deer is confined to the river bottoms.

The virtual extinction of the western white-tailed deer over much of its former range is in a sense probably due to this choice of habitat, for the one preferred by it was the first to be preempted by the white men. Their routes of travel lay along streams, and the fertile bottom lands were the first to be used as places of permanent residence.

In the Okanagan Valley the white-tail has suffered decrease to the verge of extinction. There are probably a few individuals still remaining in the vicinity of Osoyoos Lake and north along the valley of the Okanagan River to Vasseaux Lake, where in 1931 approximately 25 individuals were estimated to be living in the willow swamps around and to the south of the lake. As late as 1901 Major Allan Brooks found them in the vicinity of Penticton where he secured two specimens still in his possession as mounted heads. Recently there has been an influx of white-tails into the Okanagan Valley from the west Kootenay and the Arrow Lakes via Fire Valley and the Monashee Pass. These animals have become established in the vicinity of Enderby, Fire Valley and Mabel Lake, and are the northernmost white-tails in western British Columbia. The report of this race on the Fraser River between Quesnel and Fort George by Gosnell (1911:308) is erroneous.

In the West Kootenay the species is found in suitable localities throughout the length of the valley, north at least to the northern extremity of Upper Arrow Lake. In the extreme eastern part of the Province, specimens have been examined from Yahk, Newgate and Waldo, and the species is commonly found along the Kootenay River and on the lower slopes of the McGillivray Range. The species seems to have extended its range northward within recent years; Williams (1928:137) writes that "Virginia deer have not hitherto been found in the [Jasper National] Park but recently a band has come into the southern area and is making its home on the upper Athabaska and Chaba rivers, while a few odd ones have been seen as near [to Jasper, Alberta] as the Astoria River Valley."

White-tailed deer still are common in northwestern Washington. In Oregon, Walsingham (1873:561) mentioned them as then found on the plains about Klamath Marsh and on the headwaters of the Deschutes River. In 1934 Stanley Jewett wrote me that "in eastern Oregon, there are possibly a few in the Fox Valley section of Grant County and possibly some in the vicinity of Davis Lake, Deschutes County, although nothing definite is known of the deer in these * * * localities during the past five or six years."

A record for Nevada is furnished by D. McLean, who tells me that on September 21, 1934, he and A. L. Brown saw a small white-tail buck on Rush Creek, Washoe County, one-fourth mile east of the California-Nevada boundary.

If the species still occurs in California, it is rare there. The pair of antlers examined from the head of the south fork of the Pitt River, in Modoc County, does not provide basis for positive racial identification, though I am fairly certain that the antlers are not those of *O. v. leucurus*. Dixon (1927:308) mentions an adult male taken late in January, 1922, by William Horn, about 8 miles northeast of Observation Peak, Lassen County, 3 miles west of the state boundary. The animal is said to have been saved as a study specimen, but I have been unable to ascertain its whereabouts. Unless, and until confirmation is possible, this record must remain somewhat doubtful. Reports of white-

tail in Mono County (McLean, 1931:342) are of an unsatisfactory nature.

Specimens examined.—Total number, 20. From Canad. Nat. Museum except where otherwise specified.

California.—Head S. Fork Pit River, Modoc Co., 1 pair of antlers (Calif. Acad. Sci.).

Oregon.—Davis Creek, Deschutes Co., 3 (Coll. Stanley Jewett).

British Columbia.—Osoyoos Lake, 2; Yahk, 5; Waldo, 1; Newgate, 2; Cranbrook, 4; Elko, 2.

Odocoileus virginianus leucurus (Douglas)

Oregon White-tailed Deer

Cervus leucurus Douglas, Zool. Journ., 4, 1829:330; Wagner, Schreber's Säugethiere, Suppl. 4, 1844:375; Richardson, Fauna Bor. Amer., 1829:258; Audubon and Bachman, N. Amer. Quad., 3, 1853:77; Baird, U. S. Pac. R. R. Exp. and Surveys, 1857:649; Cooper and Suckley, Nat. Hist. Wash. Territ., Pt. 2, 1859:134; Walsingham, Proc. Zool. Soc. London, 1873:561; Douglas, Journal, 1914:58.

C[ervus]. leucurus, Schinz, Syst. Verz., 1844:381.

Cariacus leucurus, "Lesson, Nouv. Tabl. Regne Anim., Mamm., 1842:173;" Gray, Cat. Rum. Mamm. Brit. Mus., 1872:83; Brooke, Proc. Zool. Soc. London, 1878:919.

Odocoileus leucurus, Thompson, Forest and Stream, 51, 1898:286; Miller and Rehn, Proc. Boston Soc. Nat. Hist., 30, no. 1, 1901:16; Miller, U. S. Nat. Mus., Bull. 79, 1912:388; Jewett, The Oregon Sportsman, 2, 1914:5; Hall, Murrelet, 13, no. 3, 1932:67; Miller, U. S. Nat. Mus., Bull. 128, 1924:486.

Odocoileus virginianus leucurus, Lydekker, Cat. Ung. Mamm. Brit. Mus., 4, 1915:162; Taylor and Shaw, Occ. Papers Chas. R. Conner Mus., no. 2, 1929:30; Seton, Lives of Game Animals, 3, pt. 1, 1929:235; Bailey, Nat. Mag., 21, no. 3, 1933:126.

Reduncina leucura, Fitzinger, Sitzungsber. k. Ak. Wiss. Wien, 68, pt. 1, 1873:357; 78, pt. 1, 1879:323.

Type.—Male, adult; not preserved; taken on North Umpqua River, Oregon, near its head waters at a point where "course of river north west; bed sandstone; ninety yards broad; not deep * * * two hundred yards below is a small rapid in several channels and a small grassy island" (Douglas, Journal, 1914:223); October 17, 1826; collected by David Douglas.

Range.—Formerly southwestern Washington and western Oregon from lower end of Puget Sound (Steilacoom) south to Roseburg, Douglas County, Oregon, but now extinct over most of this area.

Measurements.—An adult male measures: total length, 1610 mm.; tail, 185; ear from notch, 115; ear from crown, 145; metatarsal gland, 16. Measurements of the skull of two adult males are: Basilar length of Hensel, 243 (243–243) mm.; nasal length, 69 (67–72); greatest width of nasals, 23 (22–24); orbital width, 59 (57–62); zygomatic width, 105 (104–106); upper molar series, 74; palatal breadth, 44 (43–44); lower molar series, 85; post palatal width, 24 (23–25); length of external nares, 72; width of external nares, 26; diastema, 65; width of Pm^2, 10.

Coloration.—Winter pelage: Color pattern much as in *O. v. ochrourus* but dorsal surface darker due to narrowness of light annulation; poorly defined dark line mid-dorsally on back of neck and

shoulders; dorsal surface of tail Light Ochraceous Buff near base, distal part darker with hairs dusky to tip; brow patch with prominent suffusion of chestnut; white of underparts not reaching axillae. Summer pelage unknown.

Comparisons.—See account of *O. v. ochrourus*. The cranial outlines and proportions of adult specimens of *leucurus* are those of juvenile *ochrourus* at the time the permanent premolars are just erupting, with the following exceptions: Palate as described above, ending relatively more anteriorly; upper and lower molar series shorter; M^3 reaching plane of skull as described above. In comparing adult specimens, however, the actual differences seem to be so great as to preclude any possible confusion of the two races.

Antlers.—The antlers of *leucurus*, though of strikingly small size and delicate proportions, when compared with those of any of the other northern races of *O. virginianus* are still of typical white-tail form. In addition to the two adult male skulls and skins, Mr. Jewett has also two sets of antlers on the frontal plates and two odd antlers, all from the Short Ranch, 8 miles northeast of Roseburg, Oregon. These antlers are remarkably uniform as to size and number of tines, each having three crown tines and a sub-basal snag. These are of the same general size as those of the Arizona white-tail (*Odocoileus couesi*), but differ from these, and also from typical adult antlers of *ochrourus*, in being much more erect, the main beam not bending forward to the same extent after giving rise to the brow tine. See Fig. 59.

The material seen indicates that the antlers of this deer are smaller than those of any other race north of the Mexican Boundary with the possible exception of *Odocoileus virginianus clavium* of Florida.

Remarks.—In the original description of "*Cervus leucurus*" (Douglas, 1829) the first measurements given, those of the externals, are of the specimen described in Douglas' Journal as taken on the headwaters of the North Umpqua River, Oregon. This place and not "Falls of the Willamette River, Oregon," as stated by Bailey (1933: 126), is the type locality. The latter designation was based on the first mention of the species in Douglas' Journal (1914:58), Bailey having apparently lost sight of the fact that the Journal was not published until 1914, whereas the original description was published in 1829.

The antler measurements cited in the original description are those of an adult male taken on October 13, 1826 (Douglas, *op. cit.*: 221), some three days journey (or about 30 miles) north of the Umpqua River on the route of travel of Douglas and his party. This route lay along the west slope of the Cascade Mountains on the east side of the Willamette Valley, thence over the divide from the Willamette drainage basin into that of the Umpqua.

This race was an inhabitant of the river bottoms of the Canadian and Transition life zones. Douglas (1829:331) states that the species was the most common of any in the districts adjoining the Columbia, especially on the fertile prairies of the Cowalidske (Cowlitz) and Multnomah (Willamette) rivers. Baird (1857:652) records a specimen from Steilacoom, Washington Territory. Jewett (1914:5) writes that "the White-tailed Deer, according to old residents, was formerly common throughout the Willamette Valley foothills." Common in the

foothills about Beaverton, Washington County, as late as 1875; a few present in Linn County near Sweet Home prior to 1913.

In late years the numbers have been greatly depleted. According to Mr. Stanley Jewett of Portland, Oregon (letter of February 14, 1934), "The only white-tails now existing, to my positive knowledge, are in Douglas County, Oregon, adjacent to Roseburg and Sutherlin. There are most certainly none along the Columbia River anywhere. To the best of my knowledge and belief there are none now left in the Long Tom River section of Lane County."

Bailey (1933:126) shows the range of *leucurus* to extend from northern California to and including the lower Fraser Valley of southern British Columbia. Walsingham (1873:561) also gives hearsay reports that *leucurus* was not uncommon in Shasta County, California. Lord (1866:183) and Tyrrell (1888:6) also mention this deer as present in the lower Fraser Valley, but Lord also records it from Vancouver Island, British Columbia; all these reports are probably based on sight misidentifications of *O. h. columbianus*. The specimen recorded and figured by Baird (*op. cit.*: 650, 651) as being from Whidby Island, Puget Sound, is undoubtedly a specimen of *columbianus*, the antler figured having all the characters of a three-point antler of this race and none of the characteristics of a white-tail antler.

Specimens examined (complete).—Total number 2, both from collection of Mr. Stanley Jewett.

Oregon.—*Douglas County:* Short Ranch, 8 miles north of Roseburg, 2. Additional antlers from same locality.

Odocoileus hemionus hemionus (Rafinesque).

Rocky Mountain Mule Deer

Cervus hemionus Rafinesque, Amer. Monthly Mag., 1, 1817:436.

Cariacus macrotis, Brooke, Proc. Zool. Soc. London, 1878:921; Townsend, Proc. U. S. Nat. Mus., 10, 1887:163; Tyrrell, Proc. Canad. Inst., 1888:6; Bryant, Zoe, 1, no. 12, 1891:353; Gosnell, Yearbook of Brit. Col., 1911:308.

Cariacus richardsonii, Gosnell, Yearbook of Brit. Col., 1911:308.

Cariacus virginianus, Gosnell, Yearbook of Brit. Col., 1911:308 (part).

Cervus Columbianus, Lord, The Nat. in Vancouver Isl. and Brit. Col., 2, 1866:184 (part).

Cervus macrotis Say, Narr. of S. H. Long's Exped. to the Rocky Mts., 2, 1823:88; Harlan, Fauna Americana, 1825:243; Richardson, Fauna Bor. Amer., 1829:254; Audubon and Bachman, Quad. of N. Amer., 2, 1851:206; Baird, U. S. Pac. R. R. Exp. and Surveys, 8, 1857:656; Cooper and Suckley, Nat. Hist. Wash. Territ., 1859:135; Walsingham, Proc. Zool. Soc. London, 1873:561; Douglas, Journal, 1914:62.

Cervus macrotis Var. *Montanus* Caton, Antelope and Deer of America, 1877:94.

Cervus macrotus, Lord, The Nat. in Vancouver Isl. and Brit. Col., 2, 1866:184.

Eucervus macrotis, Gray, Ann. and Mag. Nat. Hist., 18, 1866:338; Gray, Hand List of the Edent., Thick-skinned, and Rum. Mamm. Brit. Mus., 1873:157; Gray, Cat. Rum. Brit. Mus., 1872:86.

Mazama hemionus typica, Lydekker, Deer of All Lands, 1898:275.

Odocoileus hemionus, Merriam, N. Amer. Fauna no. 16, 1899:102; Elliot, Publ. Field Columb. Mus. Zool. ser. 2, 1901:42; Stone and Cram, Amer. Animals, 1902:39 (part); Elliot, Publ. Field Columb. Mus. Zool. ser. 4, 1904:76; Stephens, Calif. Mamm., 1906:48; Brooks, Canad. Mag., 29, 1907:534.

Odocoileus hemionus hemionus, Grinnell, Proc. Calif. Acad. Sci., 3, 1913:367; Clarke, Calif. Fish and Game Com., Game Bull. no. 1, 1913:10 (part); Jewett, The Oregon Sportsman, 2, no. 8, 1914:5; Lydekker, Cat. Ung. Mamm. Brit. Mus., 4, 1915:178; Taylor, Univ. Calif. Publ. Zool., 12, 1916:471; Grinnell

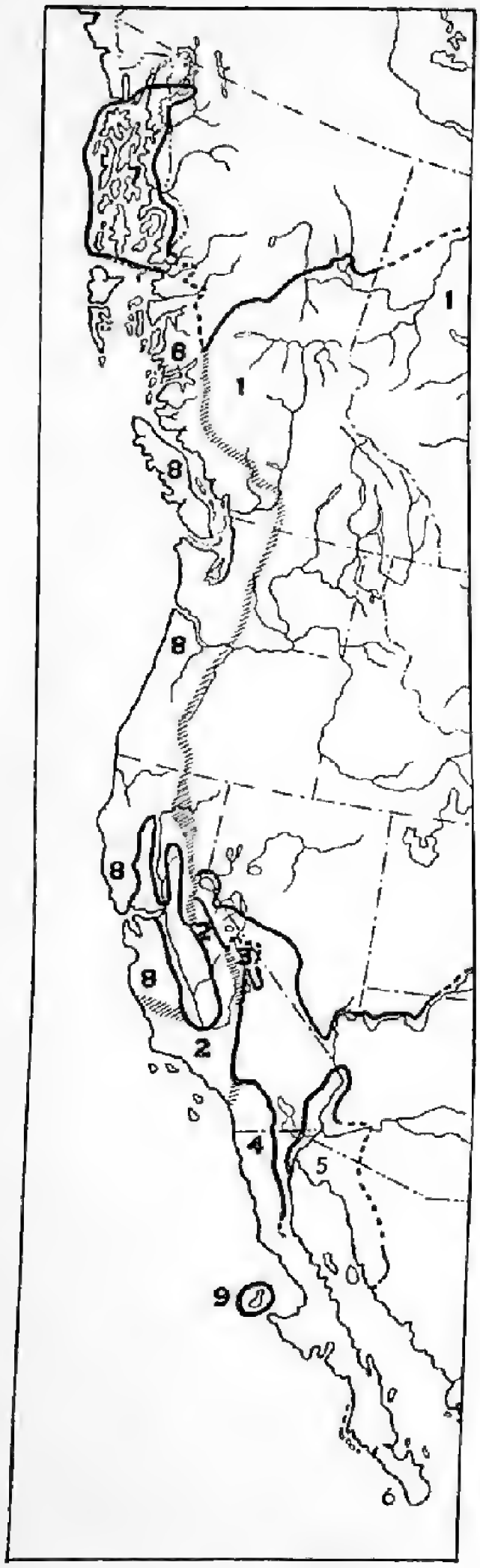


FIG. 60. Ranges of the races of black-tailed deer (*Odocoileus hemionus*) in western North America. Solid lines indicate known limits, broken lines hypothetical limits, and hatched lines areas of intergradation.

1. *Odocoileus hemionus hemionus.*
2. *Odocoileus hemionus californicus.*
3. *Odocoileus hemionus inyoensis.*
4. *Odocoileus hemionus fuliginatus.*
5. *Odocoileus hemionus eremicus.*
6. *Odocoileus hemionus peninsulae.*
7. *Odocoileus hemionus sitkensis.*
8. *Odocoileus hemionus columbianus*
9. *Odocoileus hemionus cerrosensis.*

and Storer, Animal Life in the Yosemite, 1924:231 (part); Hall, Calif. Fish and Game, 13, 1927:239 (part); Dixon, Journ. Mamm., 8, 1927:280; Taylor and Shaw, Occ. Papers Chas. R. Conner Mus. no. 2, 1929:30; Grinnell, Dixon, Linsdale, Univ. Calif. Publ. Zool., 35, 1930:569; Bailey, Nature Mag., 20, 1932:64; Grinnell, Univ. Calif. Publ. Zool., 40, 1933:207; Borrell and Ellis, Journ. Mamm., 15, 1934:42.

Odocoileus hemionus macrotis, Bailey, Nature Mag., 20, 1932:64; Sheldon, Santa Barbara Mus. Nat. Hist. Occ. Papers, no. 3, 1933:10.

Odocoileus hemonicus hemonicus Mailliard, Proc. Calif. Acad. Sci., 16, 1927:357.

Odontocoelus hemionus, Elliot, Publ. Field Columb. Mus. Zool. Ser. 6, 1905:48.

Otelaphus macrotis, Fitzinger, Sitzungsber. k. Ak. Wiss. Wien, 68, 1873:356; 78, 1879:303.

Type.—None designated; described from the journals of Charles Le Raye, Boston, 1812. Type locality in the vicinity of the Big Sioux River, South Dakota. This deer is now extinct at the type locality and unfortunately no specimens are known from elsewhere in the extreme eastern part of its range.

Range.—Great Plains, the Rocky Mountains and the Great Basin, west to the summit of the Cascade-Sierra Nevada Mountain Chain; from the Peace River, British Columbia, south to about the 39th parallel along the Sierra Nevada and to Charleston Peak, Nevada.

Measurements.—Externals: Two adult males from Modoc and Siskiyou counties, California, average as follows: Total length, 1755 (1710–1800) mm.; tail, 152 (134–175); hind foot, 555 (525–585); ear from crown, 235 (221–250); metatarsal gland (dried skins), 129 (108–150). Weights of adult males without viscera vary from 145 to 380 pounds. Live weights would be approximately 174 to 456 pounds. This great range of variation as regards body weight is typical of the genus at least in its northern representatives.

Corresponding measurements of two adult females from Modoc County, California, are: Total length, 1435 (1240–1530) mm.; tail, 175 (160–190); hind foot, 475; ear from crown, 235 (228–243); metatarsal gland (dried skins), 108 (101–116). An adult female from Siskiyou County, California, weighed 125 pounds.

Skull: Average and extreme measurements of 10 adult males from Modoc County, California, are: Basilar length of Hensel, 274 (263–288) mm.; nasal length, 95 (87–111); greatest width of nasals, 34 (33–50); orbital width, 87 (82–93); zygomatic width, 122 (117–133); mastoid width, 88 (80–101); upper molar series, 78 (75–82); lower molar series, 89 (85–94); palatal breadth, 56 (54–64); length of external nares, 79 (73–84); width of external nares, 39 (34–45); diastema, 76 (71–83).

Corresponding measurements of 2 adult females from Modoc and Siskiyou counties, California, are: Basilar length of Hensel, 252 (238–266) mm.; nasal length, 89 (83–95); greatest width of nasals, 31 (30–31); orbital width, 76 (75–77); zygomatic width, 109 (105–113); mastoid width, 73 (71–75); upper molar series, 77 (74–81); lower molar series, 86 (84–87); palatal breadth, 50 (49–50); length of external nares, 69 (63–74); width of external nares, 31 (28–33); diastema, 70 (68–72).

Coloration.—Winter pelage: General color tone of sides and back near Cinnamon-Buff (17′′*b* to 17′′*c*); fine black tip to each hair; subterminal band Pinkish Buff; base of each hair Light Drab distally,

shading to whitish proximally. The greater relative lengths of the black tips on the dorsal region give this area a darker hue, but there is no clearly defined mid-dorsal dark line. Hairs of brow patch with short black tips and broad whitish subterminal bands, giving the patch as a whole an almost white appearance; brow patch bordered anteriorally by V-shaped line of Benzo Brown extending from point on mid-line of nose 1½ inches anterior to eyes, to point midway along each eyebrow; eyelids black; nose and side of face whitish, the latter with a wash of Pale Buff from angle of mouth to meet dark color of neck; spots dorsally and laterally at base of rhinarium, Fuscous Black; chin white; small Fuscous spot on each side of lower lip restricted and generally not meeting on mid-line; throat white. Ear, outside gray; inside, spot at base and extending one-third way up posterior surface, white. Brisket blackish on mid-line, shading into dark gray on sides of chest; axilla, inguinal region, belly, inside of fore leg and inside of hind leg to hock, white with faint wash of fawn varying individually as to extent and intensity; genital region, rump, base of tail and band completely encircling base of tail, white; tip of tail black; proximal half of tail naked below. Outside of fore leg above knee, same color as back; below knee, near Clay Color (15′ *h*); hind leg below hock Pinkish Buff.

Summer pelage: Color of dorsal surface near Cinnamon-Buff (17′ *c*); hairs white at base and with thin tapering black tips; mid-dorsal area darkened by presence of many hairs with long black tips, this darkened area in some specimens forming a definite mid-dorsal line from base of skull to base of neck, spreading out and becoming less definite on body, and concentrating in a dark spot at base of tail; brow patch generally absent or very faint and without definite anterior V-shaped mark; nose and sides of face yellowish brown; dark spots on lower lip and at base of rhinarium same as in winter but browner, that is to say, not so black; throat white; ears not naked, inside white, outside yellowish, with tip and anterior margin Fuscous; underparts same as back but pinker and hairs without the black tips; in some specimens brisket dusky brown, but generally same color as chest; legs and rest of underparts same as in winter; rump patch less extensive.

Metatarsal gland with two-thirds of its length above mid-point of shank; same color as leg or slightly lighter, and surrounded by narrow area of stiffer, downwardly directed hairs, 30 mm. in length, and completely encircling gland. Hairs of tarsal tuft 35 mm. in length, yellowish white around margin of tuft, becoming sepia toward center; bases of tarsal hairs for two-thirds their length Dark Quaker Drab, in marked contrast to pale gray bases of surrounding hairs.

External comparisons.—In winter pelage *hemionus* differs from *columbianus* as follows: Size larger; general body color lighter, more gray and less rusty; brow patch paler, whitish rather than with strong suffusion of sepia; nose and sides of face paler, white or light gray rather than brownish; ears longer, usually greater than, rather than less than, 225 mm., measured from crown, shaggy, basal white spot larger, black rim more sharply contrasted; white markings of throat confined to chin and under jaw and not reproduced in second patch half way down neck; legs paler, due to lighter color of hair bases and relatively longer light hair tips; white of underparts less extensive; rump patch large and surrounding base of tail, rather than small and

not surrounding tail; chest and brisket darker, blackish rather than brownish. Tail of *hemionus* white with black tip, constricted basally and naked ventrally for one-half its length, thus contrasting strongly with that of *columbianus* which is brown or black dorsally, not markedly constricted, and not naked for half its length ventrally. In summer pelage, *hemionus* differs from *columbianus* in being more yellowish on dorsal surface, near 17″*e* (Cinnamon-Buff) rather than 16″*b*; ears more woolly and more completely haired; metatarsal gland longer and situated largely above mid-point of tarsus.

O. h. hemionus differs from *Odocoileus hemionus inyoensis* in having: Average size greater; general coloration brownish rather than yellowish, the light bands on the hairs being nearer Cream Buff than Pinkish Buff; brow patch whiter, less yellowish and less clearly defined, with anterior dark V-shaped mark smaller; chin white, occasionally with short median stripe of brownish colored hairs, as opposed to chin with prominent mid-ventral stripe of Fuscous extending forward to within three-fourths inch of anterior margin of lower lip; white of rump patch surrounding base of tail instead of being interrupted by a mid-dorsal projection of brown color of back onto root of tail; mid-dorsal dark stripe less definite; white of underparts restricted and not extending forward onto breast; inguinal white patch less extensive; brisket darker, blackish rather than brown; ear longer, more woolly and lighter behind with larger white spot at base; metatarsal gland averaging longer.

From *Odocoileus hemionus californicus*, *hemionus* can be distinguished by the following characters: Size larger; color of dorsal surface darker and not conspicuously unicolor; white rump patch larger, and continuous around root of tail; dark spots on lower lip reduced; tail without dark dorsal stripe usually present in *californicus*: ears longer and more woolly. In summer pelage the two races are almost inseparable on point of color. This is true especially of certain specimens of *californicus* in which the dark tail stripe is lacking. However, the metatarsal gland averages longer in *hemionus*, 129 mm. as opposed to 82 mm.

From *Odocoileus hemionus canus*, *hemionus* is readily distinguished by larger size; darker coloration; large rump patch; dorsal tail stripe absent rather than frequently present; presence of better developed dark lip spots; and presence of large anterior V-shaped brow patch as opposed to small patch of pale fuscous between eyes.

For comparison with *eremicus* see account of that race.

Cranial comparisons.—The skull of *hemionus* differs from that of *columbianus* as follows: Actually, but not relatively, larger and heavier throughout; frontal elevation more pronounced; nasals less expanded posteriorly, proportion of greatest width to length averaging 38 per cent as against 44 per cent; and lower lacrimal duct piercing orbit at or near mid-line of orbital rim rather than on anterior face of rim. The most reliable cranial characters are those of actual size difference, of which the best are: Upper molar series generally greater, rather than generally less, than 75 mm. in males and 70 mm. in females; palatal breadth between third upper molars generally greater, rather than generally less, than 53 mm. in males and 46 mm. in females.

The following average cranial characters distinguish *hemionus* from *inyoensis:* Zygomatic width 55 per cent of basilar length, measured from anterior lip of foramen magnum to posterior margin of incisive foramen, as against 59 per cent in the latter form; palatal breadth 43 per cent rather than 45 per cent of palatal length; mastoid width 72 per cent rather than 68 per cent of zygomatic width; diastema of lower jaw 80 per cent instead of 73 per cent of lower tooth row; mastoid width generally equal to or greater than orbital width.

Cranially *hemionus* differs from *californicus* in having palatal width 70 per cent or less of alveolar length of upper molar series; greatest width of nasals 38 per cent rather than 41 per cent of nasal length; width of external nares 48 per cent as opposed to 52 per cent of length of external nares; posterior margin of vomer (see Fig. 61 on page 212) paralleling basisphenoid rather than curving away from it. Besides these differences of proportion there exist many differences in actual size of cranial elements measured.

O. h. hemionus differs from *canus* in being smaller in every part measured save upper and lower molar series which are actually and relatively greater. Upper molar series averages 78 mm. and lower molar series 89 mm. in *hemionus* as against 86 mm. and 99 mm., respectively, in *canus.* In specimens examined there is no overlap in the measurements of the tooth rows: the upper molar series is less than 82 mm., and the lower molar series less than 94 mm. in *hemionus,* while in *canus* the upper molar series is more than 83 mm., and the lower molar series more than 95 mm.

For comparison with *eremicus* see account of that race.

Antlers.—The antlers of *O. h. hemionus,* like those of every other race studied, exhibit no constant characters of racial significance. They do, however, possess certain peculiarities of form useful in interspecific comparison.

The mature adult antler of *hemionus* is of the dichotomous type with a^2 and p^2 equally developed and is therefore structurally distinct from that of the white-tail type in which p^2 is suppressed in favor of a^2. Although of the same general type as those of *columbianus,* the antlers of *hemionus* differ in much larger size, usual rather than unusual possession of the perfect dichotomous antler by adult individuals; subbasal snag found to be present in 99 per cent rather than 36 per cent of antlers grown by adult animals; angle of main fork wider, averaging 82 (78–98) degrees as against 69 (54–79) degrees.

In their first year of development the antlers of the mule deer are much larger than those of the coast deer and this difference becomes relatively greater in the succeeding sets of antlers. The first antlers grown by a mule deer buck are fully developed at the age of 15 months, and though they are occasionally only simple spikes, they are usually forked; sometimes they have as many as three points on each side; the eyeguard is always lacking from the first set of antlers. The third and subsequent sets of antlers are usually of the characteristic, mature, dichotomous type, each antler bearing at least 4 crown points and a sub-basal snag or eyeguard. While this is to be regarded as the normal state, there are many known, and probably also many unknown, factors that may distort the normal growth of the antlers.

TABLE D

Antler Measurements of *Odocoileus hemionus hemionus*

Museum number	*Corona to primary fork	*Corona to tip of anterior prong	*Primary fork to posterior secondary fork	*Primary fork to anterior secondary fork	*Circumference 1 inch above corona	Spread at primary fork	Greatest outside spread	Greatest tip to tip spread
35257	298	584	174	121	143	510	610	530
36506	375	680	171	202	169	646	765	663
42089	325	618	232	139	138	610	790	750
45430	303	591	135	128	117	552	715	662
45120	315	590	118	98	135	550	745	640
Average	323	623	167	138	140	574	725	649

* All measurements, of the left antler.
All measurements are in millimeters.

Remarks.—O. h. hemionus has perhaps the widest zonal distribution of any race of North American deer. In the southern part of its range the race is characteristically a resident of the Transition Zone in the yellow pine (*Pinus ponderosa*)-mountain mahogany (*Cercocarpus ledifolius*) association but is found also in considerable numbers in the Upper Sonoran juniper-sage association, particularly during the winter, and in the summer it enters the Canadian Zone. In British Columbia it is a resident throughout the year in the Transition and Canadian zones, where it prefers the yellow pine-aspen (*Populus tremuloides*) and Douglas fir-aspen associations but is found also in fair numbers along the rivers where black poplar and chokecherry (*Prunus demissa*), together with cranberry (*Viburnum opulus*), and willow (*Salix* sp.), make up the dominant vegetation. In the mountainous regions of British Columbia the mule deer is a resident of the Hudsonian Zone in the Engelmann spruce (*Picea engelmanni*) forests. In the summer this deer is abundant around the timberline in most of the mountain ranges.

In many parts of its range the mule deer has as its wintering grounds country that is now devoted to the grazing of domestic sheep and cattle; consequently throughout the west this deer has suffered heavily in the general overgrazing that has been permitted in the last few years. In these areas winter starvation has greatly reduced the numbers of deer or eliminated them completely. However, probably within the last 20 to 30 years, this deer has invaded large parts of Siskiyou, Shasta and Plumas counties, California, and in the same period, in British Columbia it has extended its range northward from the 54th to the 56th parallel.

Along the western margin of its range *hemionus* has been recorded from as far north as the Peace River in British Columbia (Sheldon, 1932:199; Williams, 1933:15) and as far south as the Charleston Mountains, Clark County, Nevada (Burt, 1934:424).

In California the seasonal difference in range is fairly well known. In summer the western limits are bounded by a line extending from Little Shasta Basin, Siskiyou County, through Edgewood, Mount Eddy, Big Meadows on the McCloud River, headwaters of Squaw

Creek and along the north side of the Fall River Valley into Lassen County.

With the approach of winter those animals from north of the Medicine Lake-Ash Creek-Butte divide migrate north and east, some coming from south of the divide and passing over it. The whole population of the area winters along the north edge of the Shasta National Forest, west as far as Red Rock Valley (Moffitt, 1934:53). Most of the deer summering to the south of the mentioned divide move southward in winter along the Fall River. The animals that summer in eastern Plumas County southwest of Honey Lake along the main divide of the Sierra Nevada winter on the east slopes of Long Valley, Lassen County, California, and east into western Nevada (Moffitt, *loc. cit.*).

Specimens examined.—Total number, 116, unless otherwise indicated in the Museum of Vertebrate Zoology, as follows:

British Columbia. Westbank, Kettle Valley, 1[2]; Ashcroft, 1[6]; Ilgachuz Mts., 1[6]; Clinton, 1[6]; Kamloops, 2[6]; Kamloops district, 5; near Lillooet, 1[12]; near Vernon, 3[13]; near Princeton, 2[11]; Beaverdell, 1[1]; Quesnell, 1[1]; Ahbou Creek, 2[1]; Cottonwood, 1; Indianpoint Lake, 1.

Washington. *Yakima County:* Toppenish, 1.

Oregon. *Crook County:* Ochoco Ranger Station, 1; unstated, 1[15].

California. *Modoc County:* Hackamore Lake, 8 mi. N. Happy Camp Ranger Station, 1; Mitchell Spring, 1; Lava Beds, 1; Lookout Mt., 1; N. side Parker Cr., 1; W. side Goose Lake, 1; Crank Spring, 2; Quaking Asp, 1; Parker Cr., Warner Mts., 1; Worcester Spires, 1[5]; Day, P. O., 1; Goose Creek trail, 1; unstated, 1[6]. *Lassen County:* 7 mi. E. Wendel, 1; 14 mi. E. Wendel, 1; Eagle Lake, 1; Shafer Mt., 20 mi. SW Susanville, 3[10]; 12 mi. E McArthur, 1[6]; Ravendale, 3[5]; *unstated, 1. *Siskiyou County:* W side Glass Mt., 1; Bald Mt., 1; Buck Mt., 1; *Antelope Valley near Bray, 3; *Upper Ice Caves, 4[3]; Bray's Wells, 9[3]; *Beek? Canyon Ranger Station, 1; Lava Bed, 1; Medicine Lake Mt., 2; *Butte Cr., 2[3]; *Section 6, T41N, R1W, Shasta Nat. For., 1. *Shasta County:* Hatchet Cr., 1; Summit Lake, 1; *Buck Butte, 1; Burney Mt., 1; *Bald Mt., 1. *Plumas County:* *Head Willow Cr., 1; Mt. Crocker near Beckwith, 2; Boulder Cr., 1; Chilcoot, 1; *Kelly's, Warner Cr., 1; Chester, 1. *Tehama County:* Charles Meadows, 2. *Sierra County:* *4 mi. E Sierraville, 1; S Loyalton, 1; *Sierra County:* *unstated, 1. *Placer County:* Tahoe City, 1; *Sequoia Silver Fox Farms, probably Placer County, 1; *Pigeon Roost Camp, 1. *Nevada County:* *7 mi. E Truckee, 1; Hobart Mills, 1. *Tuolumne County:* Tuolumne Meadows, 1; Dardanelles, 1[5]. *Mono County:* Coleville, 1.

Nevada. Nye County: Barley Creek, Monitor Range, 2; 1 mile E Jefferson, 1; Toquima Peak, Toquima Range, 1; Greenmonster Canyon, Monitor Range, 1; Breen Creek, Kawich Range, 1. *White Pine County:* 8 miles N Lund, 1; Lehman Creek, 1; Baker Creek, 1; S end Ruby Lake, 1. *Lincoln County:* Monte Springs, near Irish Mountain, 1; Pahranaghat Valley, 1. *Clark County:* Charleston Mts., 1[5].

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* One or more specimens of an intermediate nature.
[1] Coll. of I. McT. Cowan.
[2] Coll. of Kenneth Racey.
[3] Coll. of Calif. Acad. Sci.
[5] Donald R. Dickey Coll.
[6] B. C. Prov. Museum.
[10] Coll. of James Moffitt
[11] Coll. of H. M. Laing.
[12] B. C. Prov. Game Branch.
[13] Coll. W. C. Pound.
[15] Oregon Game Dept.

Odocoileus hemionus californicus (Caton)

California Mule Deer

Cervus macrotis, var. *Californicus*, Caton, Amer. Nat., 10, 1876:464.
Cariacus macrotis, Bryant, Zoe, 2, 1891:113.
Cariacus macrotis californicus, Bryant, Zoe, 3, 1892:205.
Cervus macrotis, var. *Californicus*, Caton, Antelope and Deer of America, 1877:95; Caton, Amer. Nat., 19, 1885:811.
Cervus columbianus, Baird, U. S. Pac. R. R. Exp. and Surveys, 1857:xxxii (part).
Cervus Columbianus, Cooper, Amer. Nat., 3, 1869:186 (part).
C[ervus]. Mexicanus, Cooper, Amer. Nat., 3, 1869:186 (part?).
Corvus columbianus, Henshaw, App. no. 12, *in* Ann. Rep. Geog. Surv. west of 100th Merid., 1876:309 (part).
Mazama (Dorcelaphus) hemionus californicus, Lydekker, Proc. Zool. Soc. London, 1897:899.
Mazama columbiana, Ward, Records of Big Game, 1903:104 (part).
Mazama hemionus californica, Lydekker, Deer of All Lands, 1898:276.
Odocoileus hemionus californicus, Thompson, Forest and Stream, 51, 1898:286; Miller and Rehn, Proc. Boston Soc. Nat. Hist., 30, 1901:16; Elliot, Publ. Field Columb. Mus. Zool. ser., 2, 1901:43 (part); Stone and Cram, Amer. Animals, 1902:41 (part); Stephens, Calif. Mammals, 1906:51; Grinnell, Univ. Calif. Publ. Zool., 5, 1908:136; Lyon and Osgood, Bull. 62, U. S. Nat. Mus., 1908:288; Seton, Life Hist. Northern Animals, 1909:119; Miller, U. S. Nat. Mus. Bull., 79, 1912:388; Clarke, Calif. Fish and Game Comm. Game Bull. no. 1, 1913:10; Grinnell, Proc. Calif. Acad. Sci., 3, 1913:368 (part); Lydekker, Cat. Ung. Mamm. Brit. Mus., 4, 1915:179; Taylor, Univ. Calif. Publ. Zool., 12, 1916:471; Miller, U. S. Nat. Mus. Bull. 128, 1924:485; Hall, Calif. Fish and Game, 13, 1927:239; Bailey, Nature Mag., 20, 1932:64; Sheldon, Santa Barbara Mus. Nat. Hist. Occ. Papers, no. 3, 1933:15; Grinnell, Univ. Calif. Publ. Zool., 40, 1933:207.
Odocoileus hemionus hemionus, Grinnell and Storer, Animal Life in the Yosemite, 1924:231 (part).
Odontocoelus hemionus californicus, Elliot, Publ. Field Columb. Mus. Zool. ser., 4, 1904:77; Elliot, Publ. Field Columb. Mus. Zool. ser., 6, 1905:49.

Type.—Male, adult; skin and "necessary parts of skeleton for mounting" (Caton, 1876:464); number 12588/15424, Smithsonian Institution; Gaviota Pass, Coast Range, about 40 miles up the coast (west) from Santa Barbara, Santa Barbara County, California; altitude 1050 feet; collected by J. D. Caton, probably March 22, 1876 (Osgood and Lyon, 1909:288). This specimen was catalogued in the Smithsonian Institution in the spring of 1876, but nothing further is known of it (Osgood and Lyon, *loc. cit.*).

Range.—Chiefly Transition and Upper Sonoran zones in California from Orange County north on the coast to Salmon Creek, Monterey County; through the Tehachapis and northward on the western slope of the Sierra Nevada to El Dorado County.

Measurements.—Average and extreme measurements of 8 adult males from California are as follows: Total length, 1549 (1450–1710) mm.; tail, 178 (145–190); hind foot, 452 (430–470); ear from crown, 206 (192–230); metatarsal gland, 83 (57–103). Average dimensions of two females from Santa Barbara County are: Total length, 1513 (1500–1525) mm.; tail, 156 (150–163); hind foot, 443 (425–460); ear from crown, 207 (200–215); metatarsal gland, 90 (89–91).

Mature bucks average about 145 pounds (Sheldon, 1933:15). The heaviest that I know of, shot by R. F. Trelour in the San Rafael Range, Santa Barbara County, weighed 190 pounds dressed. This indi-

cates a live weight of approximately 218 pounds. Sheldon (*loc. cit.*) states that does average about 105 pounds in weight. Authentic weights available to me average about 120 pounds.

Average and extreme skull measurements of 26 adult males from Santa Barbara County are as follows: Basilar length of Hensel, 243 (230–257) mm.; length of nasals, 86 (78–94); greatest width of nasals, 35 (30–43); orbital width, 79 (68–87); zygomatic width, 113 (104–120); mastoid width, 82 (73–85); upper molar series, 72 (67–79); lower molar series, 80 (74–87); palatal breadth, 53 (47–57); post palatal width, 31 (26–36); length of external nares, 66 (59–72); width of external nares, 34 (31–38); diastema, 66 (62–72). Corresponding measurements of 4 adult females are: Basilar length of Hensel, 232 (228–238) mm.; nasal length, 80 (77–81); greatest width of nasals, 32 (29–37); orbital width, 70 (65–78); zygomatic width, 103 (98–107); mastoid width, 71 (70–72); upper molar series, 73 (72–76); lower molar series, 85 (82–88); palatal breadth, 47 (46–51); post palatal width, 30 (28–31); length of external nares, 64 (60–67); width of external nares, 32 (29–36); diastema, 61 (59–63).

External comparisons.—For comparison with *fuliginatus, inyoensis* and *hemionus* see accounts of those forms.

O. h. californicus differs from *columbianus* as follows: Metatarsal gland slightly larger; ears slightly longer; tail usually more constricted proximally; proximal half of tail naked rather than haired below; dorsal surface typically with narrow brown stripe rather than entirely brown or black. In winter pelage brow patch more nearly black, more definitely defined and lacking posterior suffusion of umber colored hairs; apex of brow patch extending anteriorly down nose, rather than without this anterior extension; general color tone colder, grayer and less reddish or yellowish; spots on lower lip larger. In summer pelage the two races differ but little, though typical specimens of each may readily be identified by giving attention to the differences in the ear and tail.

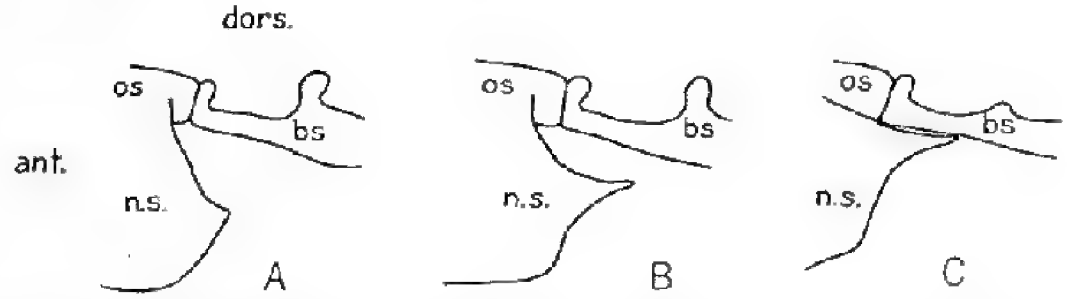

FIG. 61. Diagramatic representation of position of posterior margin of nasal septum in two races of *Odocoileus hemionus* x ½. A. and B. *californicus;* C. *columbianus.* ant., anterior; dors., dorsal; bs., basisphenoid; n.s., nasal septum; os., orbitosphenoid.

Cranial comparisons.—O. h. californicus differs from all other races in the structure of the posterior margin of the vomer (see Fig. 61) which curves sharply away from the basisphenoid, instead of paralleling that bone. Only a few specimens of *columbianus* exhibit this characteristic shape of the vomer, and most of these are from areas where *columbianus* intergrades with *californicus.* Other differences of use in distinguishing *californicus* from *columbianus* are diastema of lower jaw averaging more, rather than less, than 80 per cent of

alveolar length of lower molar series, and palatal length averaging more, rather than less, than 70 per cent of alveolar length of upper molar series. For comparison with *hemionus, inyoensis* and *fuliginatus* see acounts of those forms.

Molts.—The spring molt occurs in June and the fall one in September. In some localities the fall molt takes place considerably earlier; I have reports of males from Santa Barbara County in the winter pelage by the middle of August.

Antlers.—A majority of the skulls examined had the antlers removed, but the adult sets seen are usually smaller than those of *hemionus*. In general the antlers of *californicus* are intermediate in size between those of *columbianus* and those of *hemionus*. The angle of forking of the main branch is approximately intermediate, the subbasal snag is generally present on antlers of adult animals, and perfect dichotomy of the adult antlers is the rule rather than the exception. Antlers from the coastal regions are frequently darker colored than those of *hemionus*, but this is probably an expression of difference in immediate surroundings of the two races.

Remarks.—Odocoileus hemionus californicus is a well circumscribed race with the center of its distribution in the coast range mountains of Santa Barbara County. In these mountains it shows a degree of constancy of nearly all characters, unequaled in any other race. It favors chiefly the Transition and Upper Sonoran zones of the mountainous regions, where, on the coast, it is as much at home in the chaparral as it is in the interrupted forest type. Much the same can be said of its habitat preferences in the Sierra Nevada, where, however, it is more characteristically an inhabitant in summer of the open forest, and in the winter has its metropolis in the west-slope brush belt.

Typical specimens sometimes occur far outside the normal range. One such is available from Yuba County. Infrequently an individual of *O. h. hemionus* strays as far south in the range of *californicus* as Tuolumne Meadows.

The distribution of *californicus* in the coastal and interior mountain ranges brings it into contact with all but one of the other races inhabiting California. Intergradation with *fuliginatus* occurs in Orange County. In the vicinity of Mount Whitney, Tulare County, on the eastern margin of the summer range of *californicus*, intergradation occurs with *inyoensis*. Nevertheless, throughout much of the Sierra Nevada seasonal migrations separate *inyoensis* and *hemionus* from *californicus* throughout the breeding season and thus prevent intergradation which otherwise might occur there. However, neither in the Sierra Nevada nor in the Coast Range is there a similar seasonal isolation of *columbianus* from *californicus*. I have examined many specimens from as far south as the Merced River, Mariposa County, that were superficially *columbianus*. On closer examination, each proved to be an intermediate. Throughout the areas of contact between these two races I have found few specimens of apparent *columbianus* that did not exhibit some tendencies toward *californicus*. This applies in both the Sierra Nevada, for example at Yosemite Park, and in the coastal district from San Luis Obispo County north at least to northern Monterey County.

The characters largely relied upon by hunters when making field identifications are size of body, color and shape of tail, and length of metatarsal gland. Often these are exactly the same in certain intergrades between *hemionus* and *columbianus* as they are in typical *californicus*. Obviously, therefore, great care must be exercised in identifying individuals from the Yosemite region and immediately to the northward, and those from the coastal area of intergradation. In these regions field observations or photographs alone do not suffice for accurate identification of kind.

Specimens examined.—Total number 127, all from California. Except as otherwise indicated, specimens are in the Museum of Vertebrate Zoology.

Yuba County: Strawberry Valley, 1. *Calaveras Co.:* Near Bloods, 1. *Mariposa Co.:* Near Mirror Lake, Yosemite Park, 1; Chinquapin, 2; Big Meadows, 1; *Yosemite Valley, 2; *Eleven-mile, 1; *South Fork, Merced River, 3. *Tuolumne Co.:* Dardanelles, 3[a]. *El Dorado Co.:* Bull Bluff, 1; Head N Fork of Silver Cr., 1; *Head Poverty Canyon, 1. *Fresno Co.:* Dunlap, 2; Cedar Grove, 1; Head of Bear Cr., 1; near Kaiser Peak, Huntington Lake, 1; 6 mi. N Cedar Grove, 2; Pitman Range (locality not found), 1. *Tulare Co.:* Kennedy Meadows, 1; Jackass Meadows, 1; Mowery Meadows (locality not found), 1; Whitney Meadows, 2; *4 mi. E Springville, 1; Taylor Meadows, 1; Salt trough (locality not found), 1; *no locality more definite than county, 1. *Kern Co.:* N end Walker Basin, 1; Tejon Ranch, 1; Black Mt., 1; Bodfish, 1; Greenhorn Mt., 1; NW part of Kelso Valley, 1; Tehachapi, 1. *Santa Barbara County:* Jalama, 1; 9 mi. NE Figueroa Mt., 1; Cannessa Canyon, 1; Gaviota Pass, 4; Figueroa Mt., 3; Cachuma Canyon, E of Zaca Lake, 1; Alamos Creek, E of Santa Maria, 1; 20 mi. E Santa Maria, 1; 4 mi. E Los Olivos, 1; Paradise Camp, Santa Ynez River, 1; Zaca Canyon, 1; Little Pine Mt., San Rafael Range, 1; 25 mi. NE Santa Barbara, 1; 65 mi. NE Santa Barbara in San Rafael Mts., 1; Zaca Peak, 1; South Fork Sisquoc River, 1; Miller Canyon, 1; Cuyama Range, 5[a]; Palm Springs, 1; no locality more definite than county, 9. The following all from the Donald R. Dickey Collection: La Brea Canyon, 1; Gaviota, 2; Oso Canyon, 2; Camosa [Camuessa?] Canyon, 4; Alviso Canyon, 1; Chalk Rock, 1; Buells Ranch, Buellton, 1; San Marcos Pass, 1; Rangoss Peak, 1; Las Cruces Canyon, Gaviota, 1; Little Caliente, 1; San Marcos Pass, 1; Mission Pine, 1; Casitas Pass, 1; Santa Barbara Canyon, 1; Zaca Peak, 1; Volcano Canyon, 1; Live Oak Ranch, 1; Foxen Canyon, 1; Horse Canyon, 3; Pine Mt., 3; Gato Canyon, 1; Refugio Reserve, 2; Head Santa Ynez River, 1; Indian Canyon, trib. NE Santa Ynez River, 1; San Marcos Ranch, 1; Laguna Ranch, 1; Figueroa Mt., 2; Buckhorn Mt., 2; San Roeque Canyon, 1; Mojoque, 1; Santa Ynez River, 1; 20 mi. NE Carpinteria, 3; 25 mi. NE Santa Barbara, 1; 20 mi. NE Santa Barbara, 1; Alder Cr., Santa Ynez River, 1; Blue Canyon, Carpinteria, 1; Santa Barbara, 1; Bone Ridge, La Brea, 1; Zaca Lake, 1.

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* One or more specimens of an intermediate nature.
[a] Calif. Acad. Sci.
[b] Donald R. Dickey Coll.

Odocoileus hemionus columbianus (Richardson)

Columbian Black-tailed Deer (Coast Deer).

Cervus macrotis, var. Columbiana Richardson, Fauna Bor.-Amer., 1829:257.
Cariacus columbianus, Brooke, Proc. Zool. Soc. London, 1878:921; Bendire, Proc. U. S. Nat. Mus., 5, 1882:348; True, Proc. U. S. Nat. Mus., 7, 1884:592; Townsend, Proc. U. S. Nat. Mus., 10, 1887:164; Bryant, Zoe, 1, 1891:353; Gosnell, Yearbook of British Columbia, 1911:308.
Cariacus Columbianus, Tyrrell, Proc. Canad. Inst., 1888:6.
Cariacus Lewisii, Gray, Proc. Zool. Soc. London, 1850:239.
Cariacus punctulatus Gray, Proc. Zool. Soc. London, 1850:239.
Cariacus Virginianus leucurus, Tyrrell, Proc. Canad. Inst., 1888:6 (California, part).
Cervus columbianus, Baird, U. S. Pac. R. R. Exp. and Surveys, 1857:659; Cooper and Suckley, in Surv. N. Pac. R. R. Territ., part 2, 1859:88; Walsingham, Proc. Zool. Soc. London, 1873: 561; Caton, Antelope and Deer of Amer., 1877:97.
Cervus Columbianus, Lord, The Naturalist on Vancouver Isl. and Brit. Columbia, 2, 1866:184.
Cervus leucurus, Baird, U. S. Pac. R. R. Exp. and Surveys, 8, 1857:651 (part); Lord, The Naturalist on Vancouver Isl. and Brit. Columbia, 2, 1866:183 (part).
Cervus Lewisii Peale, U. S. Expl. Exped., 8, 1848:39 (Feather River and San Francisco Bay); Cassin, U. S. Expl. Exped., 8, 1858:59.
Cervus Richardsoni Audubon and Bachman, Quad. N. Amer., 3, 1853:27.
Dorcelaphus columbianus, Mearns, Proc. U. S. Nat. Mus., 20, 1897:468.
Eucervus columbianus, Gray, Ann. and Mag. Nat. Hist., 18, 1866:338; Gray, Cat. Rum. Mamm. Brit. Mus., 1872:86; Gray, Hand List Edent., Thick-skinned and Rum. Mamm. Brit. Mus., 1873:157.
Eucervus pusilla, Gray, Hand List Edent., Thick-skinned and Rum. Mamm. Brit. Mus., 1873:157 (British Columbia?).
Mazama columbiana, Lydekker, The Deer of All Lands, 1898:278.
Odocoileus columbianus, Merriam, Proc. Biol. Soc. Wash., 12, 1898:100; Merriam, N. Amer. Fauna, no. 16, 1899:101; Elliot, Field Columb. Mus. Publ., Zool. ser. 2, 1901:41; Elliot, Field Columb. Mus. Publ. Zool. ser. 3, 1903:181; Stone, Proc. Acad. Nat. Sci. Phila., 56, 1904:579; Stephens, Calif. Mammals, 1906:53; Ferris, Proc. Calif. Acad. Sci., 6, 1916:167; Jewett, The Oregon Sportsman, 2, 1914:5.
Odocoileus columbianus columbianus, Swarth, Univ. Calif. Publ. Zool., 10, 1912:85; Grinnell, Proc. Calif. Acad. Sci., 3, 1913:366; Clarke, Calif. Fish and Game Comm., Game Bull. no. 1, 1913:7; Lydekker, Cat. Ung. Mamm. Brit. Mus., 4, 1915:183; Brooks, Canad. Mag., 29, 1907; Kellogg, Univ. Calif. Publ. Zool., 12, 1916:378; Grinnell, Univ. Calif. Publ. Zool., 21, 1923:323; Taylor and Shaw, Mamm. and Birds of Mt. Rainier Nat. Park, 1927:117; Hall, Calif. Fish and Game, 13, 1927:241; Seton, Lives of Game Animals, 3, pt. 1, 1929:371; Taylor and Shaw, Occ. Papers Chas. R. Conner Mus., no. 2, 1929:29; Grinnell, Dixon and Linsdale, Univ. Calif. Publ. Zool., 35, 1930:562; Bailey, Nature Mag., 1932:64; Hall, Murrelet, 13, 1932:83; Grinnell, Univ. Calif. Publ. Zool., 40, 1933:206; Sheldon, Occ. Papers, Santa Barbara Mus. Nat. Hist., no. 3, 1933:19.
Odocoileus columbianus scaphiotus Merriam, Proc. Biol. Soc. Wash., 22, 1898:100; Miller and Rehn, Proc. Boston Soc. Nat. Hist., 1901:15; Stephens, Calif. Mammals, 1906:54; Lydekker, Cat., Ung. Mamm. Brit. Mus., 4, 1915:184; Grinnell, Univ. Calif. Publ. Zool., 40, 1933:207.
Odocoileus herminous Elliot, Field Columb. Mus., Zool. ser., 1, 1899:264.
Odontocoelus columbianus, Elliot, Field Columb. Mus., Zool. ser., 6, 1905:48.
Odontocoelus columbianus scaphiotus, Elliot, Field Columb. Mus., Zool ser., 6, 1905:48.
Otelaphus punctulatus, Fitzinger, Sitzungsber. k. Ak. Wiss. Wien, 78, 1879:307.
Otelaphus Richardsonii, Fitzinger, (*opus cit.*), 68, 1873:357; Fitzinger, (*opus cit.*), 78, 1879:308.
Reduncina punctulata, Fitzinger, (*opus cit.*), 68, 1873:357.

Type.—Not preserved; taken November 19, 1805, at Cape Disappointment, Pacific County, Washington; collected by hunters for the Lewis and Clark expedition.

Range.—The coast and most of the coastal islands of western North America, from central British Columbia south to central California; eastward roughly to the summit of the Cascade-Sierra Nevada mountain chain.

Measurements.—Externals: Average and extreme measurements of 13 adult males, including several ecologic races, are as follows: Total length, 1452 (1070–1620) mm.; tail, 167 (106–230); hind foot, 436 (410–485); ear from crown, 199 (171–243); metatarsal gland, 51 (25–75). Body weight of adult individuals varies from 82 pounds in Mendocino County, California, and on Lasqueti Island, British Columbia, to 238 pounds in Butte County, California. Corresponding measurements of 14 adult females including all ecologic races: Total length, 1356 (1160–1600) mm.; tail, 161 (137–190); hind foot, 433 (356–465); ear from crown (10), 192 (150–218); metatarsal gland, 51 (35–84). Live weights of as much as 112 pounds are recorded. The little data available as to body weights of females indicates that in this sex the weight is less variable than it is in the male.

Skull: Average and extreme measurements of 43 males representing all ecologic races are as follows: Basilar length of Hensel, 236 (207–263) mm.; nasal length, 79 (67–94); greatest width of nasals, 33 (29–39); orbital width, 74 (62–88); zygomatic width, 107 (96–120); mastoid width, 76 (68–90); upper molar series, 69 (58–77); lower molar series, 78 (68–89); palatal breadth, 48 (42–55); length of external nares, 63 (56–72); width of external nares, 31 (21–36); width of second upper premolar, 10 (9–11). Corresponding measurements of 14 adult females representing all ecologic races: Basilar length of Hensel, 225 (202–243) mm.; nasal length, 73 (59–81); greatest width of nasals, 30 (28–35); orbital width, 67 (61–73); zygomatic width, 100 (92–107); mastoid width, 69 (60–78); upper molar series, 68 (65–72); lower molar series, 78 (75–83); palatal breadth, 45 (42–52); length of external nares (6), 61 (55–69); width of external nares, 29 (27–35); width of second upper premolar, 10 (9–11).

Comparisons.—For comparisons with *hemionus*, *californicus* and *sitkensis* see accounts of those races.

Molts.—The time at which the winter pelage is assumed at a given locality may vary almost a month from year to year. Evidence available indicates that the adult males as a rule molt earlier than do the females, and that the younger males tend to approximate the females in time of molt. On September 15, 1927, on Gambier Island, British Columbia, all the larger bucks were in the short, new winter pelage; a spike buck taken was in the process of molt, and all the does seen were still in the red summer pelage. On September 22, 1931, at an altitude of 4000 feet on Black Mountain, North Vancouver, British Columbia, all does were still in the summer pelage, while at this date the males were nearly all in the winter coat, and the fawns of the year had already assumed their first winter pelage.

Similar conditions obtain in northern California. The earliest record of an adult in winter pelage is that of a buck taken July 12, in Napa County, California; this, however, is exceptionally early, and many individuals do not complete the molt until near the end of September. In California the molt usually occurs in August or early September.

In British Columbia the spring molt takes place from early May (Seton, 1929:370) to the end of June, depending upon the altitude and exposure of the locality, and the age, sex and physical condition of the individual concerned. The females seem to molt earlier than the males in the spring; young males molt at about the same time as the older animals, but sick or heavily parasitized individuals may retain the winter pelage long after all the animals in normal health have assumed the new coat. In California the spring molt seems to take place at about the same time as in the more northerly parts of the range of the race.

Antlers.—Although the antlers of *O. h. columbianus* do not afford characters for certain identification of the race, they possess characteristics that, when appreciated, serve to differentiate them rather readily from those of all the adjoining races except *californicus*.

The mature adult antler of *columbianus* is of the same dichotomous type as those of the other races of the *hemionus* Rassenkreis, but in this race the development of the perfect dichotomous antler is the exception rather than the rule, and many bucks, particularly those inhabiting areas immediately adjoining the sea coast, never produce such.

When the young buck is but four months old, the sites of the future antlers are marked by two short, velvet-covered knobs projecting dorsally and caudally, and about one and one-half inches in length. The velvet is not shed from these in the first winter, and in the following summer their growth proceeds to completion. The first antlers grown by a young male Coast Deer, maturing when the animal is approximately 16 months of age, are almost invariably single spikes and are from 2 to 5 inches, rarely more, in length. Contrary to this, the first set developed by the Rocky Mountain Mule Deer is generally forked.

Except under unusual circumstances as may result from injury or sickness, in its third autumn the male of *columbianus* strips the velvet from its first pair of "forked horn" antlers. These are branched once, and lack a sub-basal snag. In subsequent years antlers may bear a larger number of tines, until in the fourth or fifth years true dichotomous "four point" antlers are grown; each possesses 4 crown tines and a sub-basal snag. However, as has already been stated, this perfect development is exceptional, and many adult bucks have but two or three point antlers with or without the sub-basal snag. In any case, and regardless of number of points, in each succeeding year the antler has a greater basal circumference and an increased amount of basal rugosity.

The angle of divergence of the antlers from one another is another feature increasing with age; the antlers are almost parallel in youth, and ultimately diverge, coming to subtend an angle of almost 90 degrees with one another.

The mature antlers of *columbianus* differ from those of *sitkensis* in that the brow prong is smaller; primary beam (corona to primary fork) longer; anterior secondary beam not curving abruptly forward; secondary beams long rather than short and thick; crowns long and relatively slender as opposed to short and relatively thick.

TABLE E

Antler Measurements of *Odocoileus hemionus columbianus* from California

Population	*Corona to primary fork	*Corona to tip of anterior prong	*Primary fork to posterior secondary fork	*Primary fork to anterior secondary fork	*Circumference 1 inch above corona	Spread at primary fork.	Greatest outside spread	Greatest tip to tip spread
Coast	201	431	120	125	102	370	405	345
Coast	245	463	128	127	115	374	413	375
Coast	223	477	125	105	112	370	375	300
Coast	258	523	111	80	110	380	454	377
Coast	283	503	130	100	110	448	512	410
Coast	262	492	84	83	110	460	510	430
Coast average	248	482	116	103	110	400	445	378
Interior	282	555	103	115	135	470	637	452
Interior	240	480	157	113	123	450	493	450
Interior	240	480	157	113	123	450	493	450
Interior	327	595	150	120	140	480	585	500
Interior average	283	543	137	116	133	467	572	467

* Measurements of left antlers; all measurements in millimeters.

In comparison with mature individuals of the race *hemionus*, *columbianus* differs in having sub-basal snag present on only 36 per cent rather than on 99 per cent of the antlers; angle of primary fork averaging 69 degrees (54–79) rather than 82 degrees (70–98).

Through the kindness of Mr. R. O. Rompont of Ukiah, California, I have been able to obtain the measurements of the entire series of antlers grown by a single male of this race. These measurements are given in Table C (p. 184). The accompanying table, E, gives the measurements of several fully adult sets of antlers from various sources.

Remarks.—In explanation of the statement of type locality, as here given, it may be noted that Richardson (1829:257) in the original description of *columbianus* cites the London edition of Lewis and Clark, 1817 (misquoted 1807), pages 26 and 125. The description given by Richardson is taken verbatim from page 26 of this edition (found in Thwaites, 1905, **4**: 87, and Coues, 1893, **3**: 843). This early account (1817, p. 26) was written at Fort Clatsop, Oregon, but without reference to any specimen, itself being merely an expansion of the diagnostic description of three specimens taken at Cape Disappointment (now Washington) on Nov. 19, 1805 (Thwaites, 1905, **3**: 234 and 237; Coues, 1893, **2**: 715). This description was seemingly overlooked by Richardson. The second citation by Richardson (*vide supra*) refers nominally only to two deer probably taken at Cruzattes (Wind) River, Skamania County, Washington. It would seem to be in the interest of exactitude to correct Richardson's error of omission, and to estab-

lish the type locality as Cape Disappointment, Pacific County, Washington.

The northern limit of range is not definitely known. I have examined specimens from as far north as Bella Bella that were typical *columbianus*. Hornaday (1907:39) records a specimen from Fort Simpson, British Columbia, as *sitkensis*. Somewhere between these two points the ranges of these two races meet. The Queen Charlotte Islands lacked deer, until animals obtained on Porcher Island were introduced there. These deer seem to be well established.

There are occasional reports of individuals of this race wandering far to the east of its normal range. Mr. Fergus of Williams Lake, British Columbia, told me in 1931 that in the fall of 1930 he accidentally ran down three deer on the Caribou Highway near Lac la Hache and that one of these, a doe, proved to be a coast deer. Further enquiry substantiated his statement. Seton (1929, pt. 1:379) records a coast deer, possibly a hybrid, taken in the "Caribou Mountains, 60 miles north of Kootenai Lake, B. C." However, the two regions mentioned are much more remote from one another than indicated, and undoubtedly some error was made in recording the locality of this specimen.

Although the summit of the Cascades separates *columbianus* from *hemionus* at most places where their ranges approach one another, the two actually meet and intergrade at a few places. One place of this kind is the Pemberton Valley in British Columbia, and Taylor and Shaw (1929:29) state that *columbianus* ranges through some of the low passes to the eastern side of the Cascades in Washington, where hybridization occurs with the mule deer.

The eastern margin of range in California varies with the season. The spring migration takes the coast deer as far east in Siskiyou County as Medicine Lake, in Lassen County to Eagle Lake, and in Placer County to Lake Tahoe. In the winter there are probably no individuals of this race east of Shasta and western Siskiyou counties in the north, and east of the summit of the Sierra Nevada farther south. To the south, *columbianus* occurs on the coast at least to Monterey, in the coast range to Laguna Ranch, Gabilan Range, San Benito County, and along the western side of the Sierra Nevada to the Merced River.

In the northern parts of its range (British Columbia and Washington) *columbianus* occurs in the Canadian and Hudsonian zones. Seasonal migrations swing a large part of the population up to the upper part of the Hudsonian Zone and even into the Alpine-Arctic Zone in the summer months and down into the less rigorous Canadian Zone during the winter. Though the autumn migration results from the onset of severe weather in the higher ranges, and is a very definite movement, the spring migration is accomplished more gradually. Here in the north this deer occurs also in the Transition Zone where it is abundant on the islands in the Gulf of Georgia and Puget Sound.

In the northern section of its mainland range, however, *columbianus* favors the mixed deciduous-conifer marginal forest embracing the Douglas fir-salal association and sub-alpine mountain meadows.

In Oregon and California the Columbian Black-tail is more a deer of the Transition and Canadian zones, but it is abundant also in the Upper Sonoran chaparral belt of the coastal region of Mendocino

County and southwards. In the coastal portions of California the habitats favored are: Redwood; scrub oak; and chaparral; while in the Sierran region the foothill chaparral belt, and the yellow pine-chaparral belt support the bulk of the population.

The geographic distribution of *columbianus*, extending as it does along so great a part of the Pacific Coast of North America, brings this race under the influence of a wide variety of environments. It is not surprising, therefore, to find a notable variation in characters, and also, under certain conditions and in certain areas, a tendency to vary in a given direction. This variation permits one to recognize ecologic races or populations, which differ from the adjoining individuals of the race proper in size and some minor characters, although they do not merit taxonomic recognition.

For example, a gradual increase in body size takes place from the south to the north, specimens from the mainland and larger islands of southern British Columbia greatly exceeding those from coastal California, both in lineal and mass measurements. Even within California two extensive populations which differ from one another in the average of certain characters can be discerned: a coastal one characterized by smaller size, slightly darker color, smaller antlers and smaller average cranial measurements; and an interior population of larger individuals, with lighter color, heavier antlers and generally greater cranial dimensions. No appreciable difference in metatarsal gland, shape and color of the tail, or cranial proportions exists between these "ecologic races." The former inhabits, roughly speaking, the counties of Mendocino, Humboldt and Sonoma; the latter, Trinity, Siskiyou, Plumas and the counties on the west slope of the Sierra Nevada as far south as the Merced River, Mariposa County.

Also in British Columbia two populations can be distinguished on the basis of differences in the averages of certain characters. These two populations now are isolated as a result of the inundation of coastal valleys in Pleistocene time. The smaller, coastal population is confined to Vancouver Island and certain of the smaller adjacent islands, of which there is a great number in the Gulf of Georgia and the coastal waters to the north. These islands are roughly separable into two groups, those such as the San Juan Islands, Gabriola Saltspring, Galiano and Valdez islands, that form a reef-like chain up the east coast of Vancouver Island, and those such as Gambier, Bowen, Anvil, Nelson, Calvert, etc., that are more nearly adjacent to the mainland coast. These latter and the British Columbian mainland coast as far east as the summits of the Cascades, and mainland Coast Ranges, and for an indeterminate distance north, are inhabited by a population of deer differing from the Vancouver Island population in that many individuals reach larger size, have larger skull, much longer tooth row and greater palatal breadth.

Both of the British Columbian populations differ from both of the California populations referred to above in but one appreciable aspect besides size, namely, that in California specimens the amount of black on the dorsal surface of the tail tends to vary, ranging from terminal half black to entire dorsal surface black, with the majority of individuals having at least the terminal two-thirds black. British Columbian specimens, on the other hand, have the black confined to the tip or terminal third of the tail, in which character they approach *sit-*

kensis. As compared with the coastal population of California, the Vancouver Island population, besides having tail differences as outlined, has the summer coat slightly redder. These are the only differences I can detect. Six adult bucks from this island, as compared with 9 from coastal California, apart from a slightly greater average size in most of the 21 cranial measurements taken, show no appreciable difference in the measurements of greatest significance. The upper and lower tooth rows in fact average exactly the same in the series under consideration.

The population of the British Columbia mainland, however, as compared with that of the interior of California, shows many fairly important differences. The deer from the mainland of British Columbia differ from the Vancouver Island population, and from both Californian populations, in the following respects: Skull (average of 3 specimens) larger in basilar length of Hensel, nasal length, greatest width of nasals, orbital width, zygomatic width, mastoid width, upper molar series, lower molar series and palatal breadth. Of these, the nasal length, and length of upper and lower molar series, show no overlap. The coastal population of *O. h. columbianus* in British Columbia may prove, upon the examination of further material, especially from Washington and southern British Columbia, to warrant recognition as a separate race.

In seeking an explanation of the differentiation of the coastal from the interior population it may be recalled that in the genera *Cervus* and *Odocoileus*, when an insular form is distinguishable from its mainland counterpart to a degree which warrants racial separation, one difference is the smaller size of the insular race. *Cervus elaphus atlanticus* Lonnberg and *Cervus elaphus scoticus* Lonnberg, for example, are both inferior in size to the red deer of continental Europe. *C. e. corsicanus* Erxleben is smaller than *C. e. barbarus* Bennet, its apparent nearest relative. In the species *Odocoileus virginianus*, *O. v. rothschildi* Thomas is a very small form inhabiting Coiba Island, west coast of Panama, and *O. v. margaritae* Osgood, of Margarita Island, Venezuela, is described by Lydekker (1915:174) as an insular representative of *Odocoileus virginianus gymnotis* Wiegmann, distinguished by its smaller size and proportionately smaller skull. In the mule deer group the sole insular form, *Odocoileus hemionus cerrosensis* (Merriam) is of smaller size than either of the races on the mainland immediately adjoining. No instance is known in which an insular form is larger than the related form on the adjoining mainland. Parenthetically I might suggest that if size alone be the only distinguishing feature of these named forms, then doubt arises as to the justification of recognizing them in nomenclature.

Examining *columbianus* with these facts in mind it is not surprising that the population of Vancouver Island, even though not racially distinct, is nevertheless inferior in size, both of body and skull, to the population on the adjoining mainland. That the difference is not a greater one may be accounted for in part by the large size of the island. Also, by making a comparatively short swim it is possible for deer to cross from the mainland to the northeast coast of Vancouver Island and so permit a measure of cross breeding. The presence of numbers of the larger predators also may help to maintain a larger

average size of deer, through killing numbers of deer and so preventing overcrowding which in turn might result in an impoverished population.

It is well nigh impossible certainly to identify the factors involved in the production of this small size, but several possibilities present themselves. Islands, particularly if small, generally lack carnivores large enough to act as a check upon the numbers of a herbivore as large as deer; therefore, with one potent natural check absent, the numbers are likely to increase until the limited food supply is insufficient for the entire number of animals present, and starvation results in stabilization of the numbers.

If the island be a northern one, where the food factor is most critical in the winter months, the elimination will take place at the time when heavy snows and rigorous conditions in the higher interior of the island have concentrated the population around the coastal portions; consequently only the coastal vegetation on such an island is subjected to this heavy utilization and there is sufficient vegetation in the center of the island, where the animals summer, and the young are born, to furnish an adequate food supply for the next generation. Then too, in spring, in this heavily browsed coastal strip of a northern island, large quantities of succulent annuals, and other kinds of deciduous vegetation appear. The total population of deer on such an island, then, is limited by the available food during the winter months, when only a comparatively small part of the island is habitable.

If, on the other hand, the island be of more southerly location, the population probably would be less concentrated, and no serious conflict for food would be expected until the entire island was overpopulated. Then the vegetation might be so highly browsed that the young deer would be unable to obtain an adequate supply of suitable food, or the effect on the food plants might be such as to alter the succession to less edible or less nourishing forms. Stunted adult deer would be expected to result. Under the northern conditions, however, no such reduction in size of the individuals would be expected to take place, because the young have an abundant food supply during the growing season.

Another consideration applying to the more southern islands is that with the increase of population the opportunity for spread of parasites and disease is increased, and the deer would be expected to suffer accordingly as regards size and general development. These conditions have been found actually to obtain on certain of the islands of southern British Columbia. There, on Texada and Lasqueti islands, which are too far removed from larger bodies of land to permit of passage of deer to and from them, the deer are smaller than at any other places in the coastal district. Also, on these islands disease and parasites are of more frequent occurrence than on the adjoining mainland. It is possible also that on these smaller islands the same factors that tend to dwarf the vegetation also tend to render it a less fit food for herbivores.

On some islands isolation has possibly fostered the selection of genetically new races of deer, but where size alone is the differentiating feature, I am inclined to put greatest weight upon the somatic influences outlined above, together with those of humidity, water supply

and availability of mineral substances. Inbreeding and lack of migration may, and probably do, also aid in modifying the animals.

The same factors thought to have been responsible for the differentiation of insular and mainland populations of *columbianus* in British Columbia, with but slight modification, may have been effective also in California. It is well known that in the interior of that state the bulk of the deer population moves to higher altitudes every spring, and every fall with the onset of the winter storms, returns to the lower levels. This migratory habit involves the utilization of two definite, and often widely separated, areas by an individual deer in the course of one year, and doubtless tends to conserve the food supply and probably lessens the incidence of disease and infection by certain parasites.

In the coastal region, however, the deer of California exhibit no such definite migratory movements; the population is resident throughout the year on a relatively small area. Thus the incidence of disease and parasites, with its effect upon the size of the individual, comes into play, and, also, vegetation in one area is levied upon the whole year through. Such are the conditions as they exist in the coastal belt of California where the deer are smaller than farther inland. Whether as suggested by Heape (1931) the continued habitation of an area by a large ungulate possibly resulting in the food plants changing physiologically so as to be less suitable for the animal is a factor involved here or whether high incidence of disease, parasites, absence of adequate mineral deposits, or absence of the mixing effect of migration, be responsible is not clear.

It may be noted that the discrepancy in size between inland and coastal deer is less in California than in British Columbia. In seeking an explanation one wonders if on the mainland coast of California large carnivores, absent on several of the islands of southern British Columbia, may not prevent over abundance of deer. If so, competition among deer for food is less keen and the stunting effects of malnutrition probably have not had opportunity to act.

Specimens examined.—Total number, 260; except where otherwise indicated specimens are in Museum of Vertebrate Zoology.

British Columbia—*Vancouver Island*: 15 mi. N Alberni, 1; Errington, 7; Golden Eagle Basin, 1; Golden Eagle Mine, 1; Alberni, 1; Hardy Bay, 1[a]; Sooke, 1[b]; Langford, 1[a]; Englishmans River, 1[a]; Quatsino, 1[a]; Beaver Creek, 8 mi. N Alberni, 5[c]; 5 mi. NW Beaver Creek, 2[c]; Comox, 5[d]. *Lasqueti Island*, 1[e]. *Calvert Island*, 1. *Mainland*: Bella Bella, 3[a]; Chilliwack, 1[a]; New Westminster district, 1[a]; [a]Pemberton, 2[f]; 5 mi. E North Vancouver, 1[g]; Squamish, 1[g]; Horse Shoe Bay, 15 mi. W North Vancouver, 1[g]; Black Mt., 15 mi. W North Vancouver, 2[g]; Gambier Island, 2[g].

Washington—*Jefferson County:* Clearwater P. O., 1.

Oregon—*Jackson Co.:* Ashland, 3[a]. *Douglas Co.:* Headwaters of Dags Creek, 2[h].

California—*Del Norte Co.*, 2. *Humboldt Co.:* Fair Oaks, 2; Bridgeville, 1; Van Duzen River, 1 mi. W Trinity Co. line, 2; Van Duzen, 1. *Mendocino Co.:*

[a] One or more specimens of an intermediate nature.
[b] Coll. I. McT. Cowan
[c] Coll. Kenneth Racey
[d] Calif. Acad. Sci.
[e] Coll. H. M. Laing
[f] B. C. Prov. Museum
[g] Oregon Game Dept.

Laytonville, 49; Hayes Head, 1[10]; Mt. San Hedrin, 3; near Slaughter House Gulch, Albion River, 1; Gualala, 2; 16 mi. N Hearst, 1; Covelo, 2; 30 mi. NW Cloverdale, 1; Potter Valley, 1; Willits, 1; 1½ mi. N Wendling, 1; Sherwood, 21[5]. *Trinity Co.:* Kuntz P. O., 2; Head Grizzly Creek, 1; Douglas City, 1; Granite Peak, Stewart Fork Trinity River, 1; 7 mi. SW Ruth, 1; 4 mi. NE Mt. Tomhead, 1; Scorpion, 1; South Fork Mt., 13[5]; Island Mt., 1; Helena, 1; N Fork Coffee Creek, 2; 5 mi. S. Kuntz, 2; Hay Fork, 1; Ash Hollow, 1[5]. *Sonoma Co.:* Sonoma Mt., 1; Cazadero, 1; Eehert's Ranch, ? 1; Richardson's Ranch, ? 1. *Lake Co.:* 3 mi. W Cobb P. O., 1; 8 mi. NW Middletown, 1; 4 mi. W Middletown, 1. *Marin Co.:* Mailliard, 1; Woodacre, 1; Hicks Valley, 1; Olympic Club, 1[3]; Bolinas Ridge, 1[3]. *Napa Co.:* Wooden Valley, 1; Monticello, 1; Saint Helena, 2. *Yolo Co.:* Elkhorn Station, 1; Ramsay Canyon, 1. *Alameda Co.:* near Hayward, 1; near Sunol, 2; Rice Gulch, 1; Livermore Mts., 2; Fourteen Mile House, 1. *Santa Clara Co.:* Mt. Hamilton, 2; near San Jose, 2; San Felipe Hills, SE Evergreen, 1; Grant Ranch, Mt. Hamilton, 1. *San Mateo Co.:* Pescadero, 2; San Gregorio, 2; San Andreas Lake, near Millbrae, 2; Millbrae, 5[5]; no locality more definite than county, 1. *Santa Cruz Co.:* Head Opal Creek, 1; Davenport, 1; near Santa Cruz, 2; China Grade, 1. *Colusa Co.:* Stony Ford, 1. *Monterey Co.:* Chaular Canyon, 1; Salinas, 1; *Monterey, 3; near Aromas, 1[10]. *San Benito Co.:* Laguna Ranch, Gabilan Range, 5[5]. *Shasta Co.:* Mt. Baldy, 1; Pit River near Brock, 1; McCloud River near Baird Station, 2; *Goose Valley, 1; *Lattin Camp, 1. *Siskiyou Co.:* Head Rush Creek, 1; Summerville, 1. *Tehama Co.:* *Mineral, 2; Beegum, 2; S mi. W Mineral, 1; 9 mi. NW Mineral, 1; 4 mi. S Yolla Bolly Mt., 1; *Dry Lake near Mineral, 1; near Yolla Bolly, 1. *Plumas Co.:* Warner Creek, 1; *Kelley's Warner Creek, 1. *Lassen Co.:* Lois Creek, 1. *Butte Co.:* 11 mi. S and 7 mi. W Chico, 15; Brush Creek, 3. *Mariposa Co.:* Chinquapin, 1. *Placer Co.:* Lake Tahoe, 1[10]; Pigeon Roost Camp, 1.

Odocoileus hemionus sitkensis Merriam

Sitka Deer

Odocoileus columbianus sitkensis Merriam, Proc. Biol. Soc. Wash., 12, 1898:100; Elliot, Field Columb. Mus. Publ., Zool. ser., 2, 1901:42; Miller and Rehn, Proc. Boston Soc. Nat. Hist., 30, 1901:15; Stone and Cram, Amer. Animals, 1903: 43; Osgood, Game Resources of Alaska, Yearbook, Dept. Agric., 1907:478; Heller, Univ. Calif. Publ. Zool., 5, 1909:247; Swarth, Univ. Calif. Publ. Zool., 7, 1911:113; Miller, U. S. Nat. Mus. Bull. 79, 1912:387; Lydekker, Cat. Ung. Mamm. Brit. Mus., 4, 1915:184; Miller, U. S. Nat. Mus. Bull. 128, 1924:484; Holzworth, The Wild Grizzlies of Alaska, 1930:23; Seton, Lives of Game Animals, 3, pt. 1, 1929:372; Bailey, Nature Mag., 20, 1932:64.

Odontocoelus columbianus sitkensis, Elliot, Field Columb. Mus. Publ., Zool. ser. 6, 1905:48.

Type.—Female, immature; skin and skull; no. 74383, U. S. Nat. Mus., Biol. Survey Coll.; Sitka, Alaska; August 8, 1895; collected by C. P. Streator; original number 4767 (Osgood and Lyon, 1909:14).

Range.—Coast and coastal islands of southeastern Alaska; from Dall Island north to Inian Island, Icy Straits, and on the mainland from Port Simpson, British Columbia, north to Juneau, Alaska, and casually as far north as Atlin, British Columbia; southern limits of range unknown.

Measurements.—Externals: Average and extreme measurements of 3 adult males are as follows: Total length, 1567 (1500–1650) mm.; tail, 150; hind foot, 434 (425–450); ear from notch (measured on dry skin), 129 (118–139); metatarsal gland, 41 (39–43).

Corresponding measurements of 3 adult females are: Total length, 1331 (1275–1367) mm.; tail, 159 (150–165); hind foot, 407 (400–416);

* One or more specimens of an intermediate nature.
[3] Calif. Acad. Sci.
[5] Donald R. Dickey Coll.
[10] Coll. James Moffitt
[16] Coll. Ralph Ellis

ear from notch (measured on dry skin), 122 (118–128); metatarsal gland, 44 (41–51).

Skull: Average and extreme measurements of 7 adult males are: Basilar length of Hensel, 243 (235–258) mm.; nasal length, 74 (70–82); greatest width of nasals, 33 (30–37); orbital width, 81 (79–86); zygomatic width, 114 (111–119); mastoid width, 77 (74–80); upper molar series, 68 (67–70); lower molar series, 74 (72–78); palatal breadth, 54 (50–57); length of external nares, 30 (28–32); width of Pm^2, 8.4 (8–9).

Corresponding measurements of 5 adult females: Basilar length of Hensel, 224 (217–232) mm.; nasal length, 69 (67–75); greatest width of nasals, 28 (27–29); orbital width, 70 (67–73); zygomatic width, 99 (95–102); mastoid width, 66 (65–67); upper molar series, 68 (65–70); lower molar series, 77 (73–81); palatal breadth, 46 (43–48); length of external nares, 63 (62–65); width of external nares, 27 (25–28); width of Pm^2, 9 (8–10).

External comparisons.—*O. h. sitkensis* differs from *O. h. columbianus* from Vancouver Island, British Columbia, as follows: Summer pelage less red, being nearer Cinnamon than Tawny; brow patch less extensive and without an intermixture of yellow tipped hairs in the posterior portion; dark line down top of nose more prominent. *O. h. sitkensis* differs from *columbianus* from northern California in having less black on the back; legs much darker; tip only, of tail, black; white at base of ear restricted; dark brow patch smaller and without yellow flecking.

In winter, *sitkensis* as compared with *columbianus* has the light color of body hairs more reddish, Cinnamon to Pinkish Cinnamon rather than Warm Buff; proximal two-thirds rather than proximal one-third of tail same color as back; brow patch darker, more extensive, and lacking umber suffusion posteriorly; brown chin patches restricted; cheeks browner and less grayish; lower legs and feet Cinnamon rather than buff to grayish buff.

Cranial comparisons.—Males: The skull of *sitkensis* differs in many striking respects from that of *columbianus*, the only race with an adjoining range. In *O. h. sitkensis* the skull averages actually longer, and actually as well as relatively wider; medial segment of skull relatively wider, zygomatic width 148 per cent rather than 142 per cent of mastoid width; orbital width equal to or greater than, rather than generally less than, 79 mm.; nasals relatively shorter, nasal length being 30 per cent of basilar length of Hensel as against 33 per cent; palate relatively wider, averaging 79 per cent rather than 70 per cent of upper tooth row; width of anterior process of jugal below lacrimal always less than 5 mm. (averaging 3.6 mm.), rather than always more than 5 mm. (averaging 8 mm.); lower molar series actually shorter so that upper molar series averages 92 per cent of lower molar series, as against 87 per cent; second upper premolar usually equal to or less than, rather than greater than, 9 mm. in width. Some difference in manner of jaw movement is indicated.

Females: In actual and relative proportions females of *sitkensis* bear such close resemblance to females of *columbianus* that except for two or three characters, the skulls of the two races are indistinguish-

able. The nasals in *sitkensis* are relatively as well as actually shorter, proportion of nasal length to basilar length of Hensel averaging 31 per cent as opposed to 33 per cent; however, this is an average difference and subject to considerable variation. The most reliable distinctions between the two races are: width of second upper premolar generally less than 9 mm. in *sitkensis* as opposed to generally 10 mm. in *columbianus;* width of anterior process of jugal always less than 5 mm. and averaging 3.5 mm. in the former, rather than always greater than 5 mm. and averaging 9.5 mm. in the latter.

Molts.—The Sitka Deer assumes the summer pelage in June; a specimen from Admiralty Island, taken May (20?), 1906, is still in full winter pelage, only slightly abraded, and shows no signs of molt. As in *columbianus*, the summer coat persists for but a short time, and already in August the winter pelage can be seen to be well developed under the summer hair. A specimen taken on August 28, 1919, has winter pelage on the ears and face, but the rest of the body has the long summer coat, beneath which the new winter pelage has already reached a considerable length.

Antlers.—The mature 4 point antlers of this race are so characteristic that individual antlers can at a glance, be identified as to race, and separated from the mature antlers of *columbianus*.

In 1911 Swarth (p. 115) noted that from the islands north of Frederick Sound he had never seen a 4 point antler, while on the islands to the south of that sound such were not uncommon. So far as I know no 4 point antlers have been recovered from north of Frederick Sound since the time of Swarth's observation.

The antlers of *sitkensis* can be differentiated from those of *columbianus* by the following characters: brow prong large; primary beam (corona to primary fork) short; anterior secondary beam curving abruptly forward and inward, resembling the antlers of white-tailed

TABLE F

Measurements of Four Point Antlers of *Odocoileus hemionus sitkensis*

Museum number	*Corona to primary fork around curve	*Corona to tip of anterior prong around curve	*Primary fork to posterior secondary fork in straight line	*Primary fork to anterior secondary fork in straight line	Circumference ½ inch above corona
8341	214	420	130	75	96
8351	200	379	89	86	91
8342	215	390	41	78	102
8350	200	372	107	82	100
8344	206	421	99	67	103

* Measurements of left antlers in millimeters.

deer in this respect; secondary beams short and heavy. The antlers of 7 fully adult males taken within a period of a few days at Freshwater Bay, Chichagof Island, Alaska, are remarkable in the constancy of their size, color and symmetry. All are of a dark reddish brown color, and relatively stout for their length. None of the series has the see-

ondary forking of the posterior tine (p^2). Measurements of a series of isolated 4 point antlers from south of Frederick Sound are given in the accompanying table. Measurements of the largest head examined from Chichagof Island, Alaska, are as follows: Points 3^1: : 3^1; circumference of right antler at base, 113 mm.; circumference of left antler at base, 100 mm.; length of right antler measured around curve, 426 mm.; length of left antler measured around curve, 415 mm.; greatest spread of antlers, 460 mm.; greatest spread tip to tip, 420 mm.; spread of anteriormost tips, 332 mm.

Remarks.—The Sitka Deer is confined to the heavily timbered Canadian and Hudsonian zone forests of the coastal strip of southeastern Alaska. On the islands at least, it is found from sea level to timberline; the bulk of the population is concentrated along the shore line in the winter, but it spreads out again in the summer, at which time it is of common occurrence above timberline in the Alpine-Arctic Zone (Holzworth, 1930).

A point of interest as regards the distribution of this race is that, while deer abound on all the larger islands, they are scarce on the adjoining mainland. Swarth (1911:114) says: "Deer are almost unknown along the mainland coast, a single buck seen by Hasselborg at Bradfield Canal being our only record."

O. h. sitkensis as a race possesses an unusual array of characters separating it from the more southerly ranging *columbianus*. Though originally described by Merriam (1898:100) as smaller than the latter race, examination of more complete material shows *sitkensis* to be larger throughout, both cranially and externally. When naming the race, Merriam probably had available only immature specimens. In common with the Vancouver Island Mountain Lion, *Felis oregonensis vancouverensis*, and northwestern races of other full species which range to the south and east of the humid coastal belt of northwestern North America, the Sitka Deer differs from the southern races of its Rassenkreis in the extreme redness of the pelage. This feature is most pronounced in the winter pelage.

Lack of material from the northern coast of British Columbia makes it impossible to determine the southern limits of range or to ascertain how intergradation occurs with *columbianus*. Hornaday (1907:39) has recorded *sitkensis* from Port Simpson and Swarth (1911:113) found it on Dall and Duke islands and (1922) on Farm Island in the mouth of the Stikine River. Somewhere along the coast between Dean Channel and Portland Inlet, an area of intergradation will doubtless be found to exist.

Swarth (1911:115) suggests that there may be a racial difference between the deer inhabiting the islands south of Frederick Sound and those to the north of this channel. Adult males from south of the sound are lacking, but females now available from Kuiu, Kupreanof, Mitkof and Zarembo islands show no appreciable differences from those of Admiralty Island. Though these deer inhabit all the larger islands of the Alexander Archipelago, they probably are not effectively isolated there. They are strong swimmers and are known to cross wide channels from island to island, and from the islands to the mainland. Sheldon (1912:216) relates seeing a buck and doe crossing Frederick

Sound, from Admiralty Island to the mainland where the sound was 12 miles wide.

Specimens examined.—Total number, 34, all from Alaska. Unless otherwise indicated, specimens are in the Museum of Vertebrate Zoology. Blind Slough, Mitkof Island, 2; Zarembo Isl., 1; Etolin Isl., 1; Windfall Harbour, Admiralty Isl., 2; Rodman Bay, Baranof Isl., 1; Keku Straits, Kupreanof Isl., 1; 3 mile Arm, Kuiu Isl., 3; Kupreanof Isl., 3; Egg Harbour, Coronation Isl., 1; Warren Isl., 2; Hecata Isl., 1; San Alberto Bay, Prince of Wales Isl., 2; Freshwater Bay, Chichagof Isl., 8; Very Inlet, Revillagigedo Channel, 1; Eliza Harbour, Admiralty Isl., 1; Inian Isl., Icy Straits, 3 (Collection of Donald R. Dickey); Wrangell, 1.

Odocoileus hemionus inyoensis Cowan

Inyo Mule Deer

Odocoileus hemionus inyoensis Cowan, Proc. Biol. Soc. Wash., 46, 1933:69; Grinnell, Univ. Calif. Publ. Zool., 40, 1933:207; Dixon, Calif. Fish and Game, 20, 1934:186.

Odocoileus hemionus hemionus, Clarke, Calif. Fish and Game Comm. Bull. 1, 1913:10 (part); Hall, Calif. Fish and Game, 13, 1927:239 (part).

Odocoileus hemionus californicus, Sheldon, Santa Barbara Mus. Nat. Hist. Occ. Papers, no. 3, 1933: Map between 8 and 9 (part).

Odontocoelus hemionus, Elliot, Field Columb. Mus. Publ., Zool. ser., 3, 1904:283 (part).

Type.—Male, adult; skin, skull and skeleton; no. 16363, Mus. Vert. Zool.; "Kid Mountain" at altitude of 11000 feet, 10 miles West of Big Pine, Inyo County, California; October 15, 1911; collected by H. A. Carr, orig. no. 656. The type is in good condition except that both premaxillae are missing and the caudal margin of the vomer is damaged.

Range.—Eastern slope of the southern Sierra Nevada, in Owens Valley district of California.

Measurements.—Measurements of the type are as follows: Total length, 1740 mm.; tail, 180; hind foot, 485; metatarsal gland, 94; nasal length, 85; greatest width of nasals, 34; orbital width, 85; zygomatic width, 118; mastoid width, 80; upper molar series, 79; lower molar series, 90; palatal breadth, 55; post palatal width, 34; diastema, 66; width of second upper premolar, 12.

Comparisons.—From *O. h. californicus*, *inyoensis* differs in slightly greater size; grayer cast to the winter pelage, which is predominantly yellowish gray rather than dull brownish; light color of underparts more extensive and whitish rather than washed with buff; crown patch yellowish, rather than black with gray flecking; dark stripe from apex of dark V on forehead to base of rhinarium lacking; white of inguinal region projecting anteriorly as far as axillae; brisket brownish rather than blackish; tail without, rather than usually with, dark dorsal stripe; metatarsal gland longer; skull larger in every part measured except mastoid width which is actually and relatively less, being less than, rather than generally greater than, least interorbital breadth; diastema less than 80 per cent of lower molar series; palatal width averaging less than 70 per cent of upper molar series.

For comparison with *hemionus* and *eremicus* see accounts of those forms.

Antlers.—The adult material available is so limited as not to permit of any mean evaluation of structural characters. The antlers seem to be about as in *californicus* and, therefore, smaller and lighter than in *hemionus*.

Remarks.—This race inhabits chiefly the Upper Sonoran and Transition zones, but in certain seasons small numbers probably inhabit the Lower Sonoran Zone. Its preference of habitat is not known to differ from that of *californicus*. H. A. Carr (1911, MS) quoting Mr. E. H. Ober, a long time resident in the Owens Valley region, states: "As soon as the heavy snows come at the summit [of the Sierra] the big buck deer begin to come over to this side [Owens Valley], gradually working their way down to the valley where they cross to the desert ranges when the east slope of the Sierra is covered with snow. About half way between Big Pine and Independence is where they cross. A long sandy hill projects into the valley and down this they come, crossing the marshes in the valley and the ford at the river."

In external appearance, *inyoensis* is most like *hemionus* from northern California, but in cranial characters is nearest *californicus*. From both of these races, however, *inyoensis* can be readily distinguished by the large amount of white on the underparts and breast, and by the relatively narrower mastoid region of the skull.

A few specimens of *hemionus* from Siskiyou County, California, show a tendency to have the white of the abdominal region extended forward onto the breast, but not to as marked degree as in *inyoensis*. Two juvenile specimens from the type locality agree with the type in all essentials of coloration.

On the ground of geographic probability shed antlers from the White and Inyo mountains have been referred to this race. Intergradation with *californicus* is indicated by certain specimens, from eastern Tulare County, which here are referred to *californicus*.

Specimens examined.—Total number 5, all from California. Except as otherwise indicated, specimens are in the Museum of Vertebrate Zoology. *Inyo County:* 10 mi. W Big Pine, 3; Bishop Cr. Canyon, 1 [16]; Sawtooth Peak, 1 [5].

Antlers-only from: George Cr., northeast of Mt. Bernard; 7 mi. W. Independence; south of Kearsarge Peak; Poison Cr. and Piute Monument. White Mountains; Black Mt., Inyo Mountains; Badger Flat, Inyo Mountains.

Odocoileus hemionus fuliginatus Cowan.

Southern Mule Deer.

Odocoileus hemionus fuliginatus Cowan, Journ. Mamm., 14, 1933:326; Moffitt, Calif. Fish and Game, 20, 1934:81; Dixon, Calif. Fish and Game, 20, 1934:186.
Cervus macrotis, Baird, Mamm. Mex. Bound., 1859:51 (part?).
Cervus Columbianus, Baird, U. S. Pac. R. R. Exp. and Surveys, 1857:667 (part).
Eucervus columbianus, Gray, Cat. Rum. Mamm. Brit. Mus., 1872:87 (part).
Odocoileus hemionus, Elliot, Field Columb. Mus., Zool. ser., 3, 1906:206.
Odocoileus hemionus californicus, Elliot, Field Columb. Mus., Zool. ser., 3, 1906:

[5] Donald R. Dickey Coll.
[16] Coll. of Ralph Ellis.

207; Stephens, Calif. Mammals, 1906:51; Mearns, Bull. 56, U. S. Nat. Mus., 1907:211; Stephens, Trans. San Diego Soc. Nat. Hist., 3, 1921:44; Clarke, Calif. Fish and Game Comm. Bull. 1, 1913:10 (part); Grinnell, Proc. Calif. Acad. Sci., 3, 1913:368 (part); Grinnell and Swarth, Univ. Calif. Publ. Zool., 10, 1913:321; Lydekker, Cat. Ung. Mamm. Brit. Mus., 4, 1915:179 (part); Hall, Calif. Fish and Game, 13, 1927:245 (part); Grinnell, Univ. Calif. Publ. Zool., 40, 1933:207 (part); Sheldon, Santa Barbara Mus. Nat. Hist. Occ. Papers, no. 3, 1933:15 (part).

Type.—Male, adult; skin and skull; no. 39918, Mus. Vert. Zool.; "Barona Ranch, 30 miles east of San Diego," San Diego County, California; October 8, 1928; collected by Webb Toms.

Range.—From San Jacinto Mountains, Santa Rosa Mountains and San Mateo Valley, San Diego County, at the north, southward at least to Corona, Sierra San Pedro Mártir, Lower California.

Measurements.—Externals: Average and extreme measurements of 4 young adult males are as follows: Total length, 1433 (1385–1560) mm.; tail, 164 (150–180); hind foot (2), 433 (430–435); ear from crown, 198 (185–210); metatarsal gland, 75 (60–86).

Corresponding measurements of 3 very old females are: Total length, 1553 (1390–1800) mm.; tail, 167 (150–180); hind foot, 435 (420–450); ear from crown, 210 (190–220); metatarsal gland, 78 (65–93).

Skull: Average and extreme measurements of 7 adult males: Basilar length of Hensel (3), 229 (218–245) mm.; nasal length, 80 (74–81); greatest width of nasals, 31 (27–34); orbital width, 74 (70–80); zygomatic width, 105 (96–114); mastoid width, 71 (65–74); upper molar series, 78 (75–80); lower molar series (5), 86 (84–89); palatal breadth (4), 48 (45–50); post palatal width (5), 28 (26–30); length of external nares (4), 63 (60–64); width of external nares (4), 31 (27–35); diastema, 60 (55–68).

Corresponding measurements of 3 adult females are: Basilar length of Hensel, 229 (221–242) mm.; nasal length, 82 (78–87); greatest width of nasals, 30 (29–31); orbital width, 73 (70–79); zygomatic width, 100 (95–105); mastoid width, 67 (64–71); upper molar series, 73 (72–73); lower molar series, 84 (82–88); palatal breadth, 46 (43–49); post palatal width, 28 (27–29); length of external nares, 63 (59–70); width of external nares, 32 (30–36); diastema, 60 (55–65).

External comparisons.—From both *Odocoileus hemionus peninsulae* and *californicus*, *fuliginatus* can be distinguished in fresh winter pelage by darker color throughout, produced by darker hair bases and relatively longer black tips of hairs; well defined black or blackish mid-dorsal line (often present also in *peninsulae*); dorsal line on tail broad and black, occupying greater portion of upper surface of tail.

O. h. fuliginatus differs additionally from *peninsulae* in having the dark spot at the root of the tail less conspicuous and in darker color of summer pelage.

From *californicus*, *fuliginatus* differs further as follows: Dark spots on sides of lower lip restricted and not meeting on mid-ventral line to produce a forward projecting dark bar reaching almost to anterior margin of lip; in summer pelage darker, Cinnamon rather than Cinnamon-Buff; dorsal area darkened by presence of many black tipped hairs.

For comparisons with *eremicus* and *cerrosensis* see accounts of those forms.

Skull.—Differs from *O. h. californicus* and also *peninsulae* in having second upper premolar wider, averaging 11 mm. wide in males; diastema of lower jaw averaging less than, rather than more than, 71 per cent of alveolar length of lower molar series. From *californicus, fuliginatus* differs further in that vomer is closely applied to basisphenoid; mastoid width always less than, rather than generally greater than, least interorbital breadth; palatal breadth as measured between alveoli of posterior molars generally less than, rather than generally greater than, 65 per cent of alveolar length of upper molar series; upper molar series averaging 6 mm. greater in alveolar length (78 mm. as against 72 mm.). In addition to those characters already mentioned, *peninsulae* differs from *fuliginatus* in the following respects: Dorsal outline of frontonasal region not markedly concave (see Fig. 62, p. 233); antorbital vacuity narrower dorsoventrally; rostrum horizontal along its lower margin rather than elevated; elevation of tip of rostrum (measured perpendicularly from a plane surface) less than 36 mm. as opposed to more than 42 mm. (see Fig. 62).

For comparison with *cerrosensis* see account of that form.

Molts.—The molt seems to be the same as in the more northerly races. Specimens from the Sierra San Pedro Mártir, taken on May 23 and May 25, have the winter pelage greatly abraded and the summer pelage showing on the sides and neck, and in a specimen taken on June 21 the summer coat is fairly well completed. The fall molt, at least in males, takes place early in September. One taken September 16 in San Diego County, California, has full winter pelage with only a few long red hairs still clinging to the flanks.

Antlers.—To me the antlers are indistinguishable from those of *californicus*.

Remarks.—In Lower California this race is confined to the Upper and Lower Sonoran zones, where it inhabits the broken forests and brush lands. In San Diego County, and in the San Jacinto Mountains, it occurs regularly from sea level in the Lower Sonoran Zone up into the Transition Zone in the mountains.

In external appearance, *fuliginatus* is notably different from the races adjoining it. Scarcity of material from the areas in which this race would be expected to intergrade with *californicus* and *peninsulae* makes it impossible at this time definitely to delimit its range. A single specimen from the Santa Ana Mountains of Orange County, California, shows close approach to *californicus*.

The one specimen from Mission Santa Maria, latitude 29° 45′, Lower California, Mexico, is almost exactly intermediate between *fuliginatus* and *peninsulae*. I have reason to believe that the blending of these two races takes place over a long distance; for while in the San Diegan district of California the race is uniform in character, in the region of Vallecitos, San José and Santo Domingo, Lower California, the characters often tend in the direction of *peninsulae*, and I have encountered several specimens with the cranial characters of *fuliginatus* which lacked the broad tail stripe and which had the dark patch at the base of the tail suggestive of the latter race.

Specimens examined.—Total number, 24, as follows: Unless otherwise indicated specimens are in the Museum of Vertebrate Zoology. **California:** *Riverside County:* Toro Peak, Santa Rosa Mts., 1; San Jacinto Mts., 1; Tahquitz Valley, San Jacinto Mts., 1; Thomas Mt., San Jacinto region, 1. *Orange Co.:* San Mateo Valley, 1. *San Diego Co.:* 6 mi. W Fallbrook, 1; Barona Ranch, 30 mi. E San Diego, 1; Game Refuge 4 E, 1; Colb Valley, 1; E side Laguna Mt., 1; no locality more definite than county, 1. **Lower California, Mexico:** 38 mi. S Tecate, 1[5]; Los Bancos Range, Tecate, 1[5]; Tecate, 1[5]; Vallecitos, Sierra San Pedro Mártir, 4; Corona, Sierra San Pedro Mártir, 3; La Grulla Trail, 12 mi. above San José, 1; [2]Mission Santa Maria, 1.

Odocoileus hemionus peninsulae (Lydekker)

Peninsula Deer

Mazama (Dorcelaphus) hemionus peninsulae Lydekker, Proc. Zool. Soc. London, 1897:899.

Mazama hemionus peninsulae Lydekker, Deer of All Lands, 1898:276.

Odocoileus hemionus peninsulae. Miller and Rehn, Proc. Boston Soc. Nat. Hist., 30, 1901:16; Miller, U. S. Nat. Mus. Bull. 79, 1912:388; Lydekker, Cat. Ung. Mamm. Brit. Mus., 4, 1915:181; Nelson, Nat. Acad. Sci., 16, 1921:121; Miller, U. S. Nat. Mus. Bull. 128, 1924:485; Bailey, Nature Mag., 20, 1932:64.

Odontocoelus hemionus peninsulae. Elliot, Publ. Field Columb. Mus., Zool. ser., 4, 1904:78; Elliot, Publ. Field Columb. Mus., Zool. ser., 6, 1905:50.

Type.—Male, immature; skin and skull; no. 98.3.1.172, British Museum; between La Laguna and Victoria Mt., Sierra Laguna, at an altitude of about 6000 feet, Lower California, Mexico. Collected by Dane Coolidge, July 1, 1896, original number 327.

Through the courtesy of Mr. Dane Coolidge, I have been permitted to examine the field notes of the expedition on which the type was collected. Lydekker did not have access to these, consequently it is now possible to assign the type locality with a greater degree of accuracy than heretofore.

Range.—Known only from the southern part of Lower California; from Cape San Lucas north through the Sierra Laguna, and probably considerably farther, as a specimen from Santa Maria Mission is almost exactly intermediate between this race and *O. h. fuliginatus.*

Measurements.—Externals: Average and extreme measurements of 3 adult males are as follows: Total length, 1505 (1370–1630) mm.; tail, 158 (150–175); hind foot, 397 (330–455); ear from crown, 220 (200–235); metatarsal gland, 88 (78–106).

Corresponding measurements of 3 adult females are: Total length, 1445 (1315–1580) mm.; tail, 166 (115–200); hind foot, 395 (325–455); ear from crown, 214 (203–230); metatarsal gland, 95 (90–100).

Skull: Average and extreme measurements of 3 adult males: Basilar length of Hensel, 254 (253–257) mm.; nasal length, 86 (82–93); greatest width of nasals, 33 (30–36); orbital width, 84 (83–85); zygomatic width, 117 (114–119); mastoid width, 82 (79–87); upper molar series, 80 (77–82); lower molar series, 89 (86–91); palatal breadth, 52 (49–55); post palatal width, 32 (31–32); length of external

[2] Specimen of intermediate nature.
[5] Donald R. Dickey Coll.

nares, 69 (67–71); width of external nares, 35 (34–37); diastema, 68 (67–68); width of Pm^2, 10; elevation of rostrum, 47 (42–53).

Measurements of 2 adult females are: Basilar length of Hensel, 243; nasal length, 84 (82–86); greatest width of nasals, 31 (29–32); orbital width, 73 (69–78); zygomatic width, 108 (107–108); mastoid width, 73 (70–76); upper molar series, 78 (76–81); lower molar series, 90 (87–94); palatal breadth, 49 (47–51); post palatal width, 28; length of external nares, 65 (64–66); width of external nares, 31 (30–32); diastema, 64 (63–65); width of Pm^2, 10; elevation of rostrum, 46 (42–49).

External comparisons.—From *eremicus, peninsulae* differs in having dark spot at base of tail; dark dorsal line present rather than absent; rump patch smaller.

For comparison with *fuliginatus* and *cerrosensis* see accounts of those forms.

Cranial comparisons.—Frontals greatly depressed anteriorly and elevated posteriorly, in this character differing widely from *californicus,* in which there is no concavity of the frontals and relatively little elevation of these bones posteriorly. Antorbital vacuity short and broad rather than long and narrow, therefore resembling *hemionus* more closely than *californicus* or *fuliginatus;* ascending rami of premaxillae generally not reaching nasals; lower lacrimal duct piercing orbit anterior to mid-line of orbital rim. Rostrum greatly elevated (see Fig. 62); posterior margin of vomer paralleling basisphenoid.

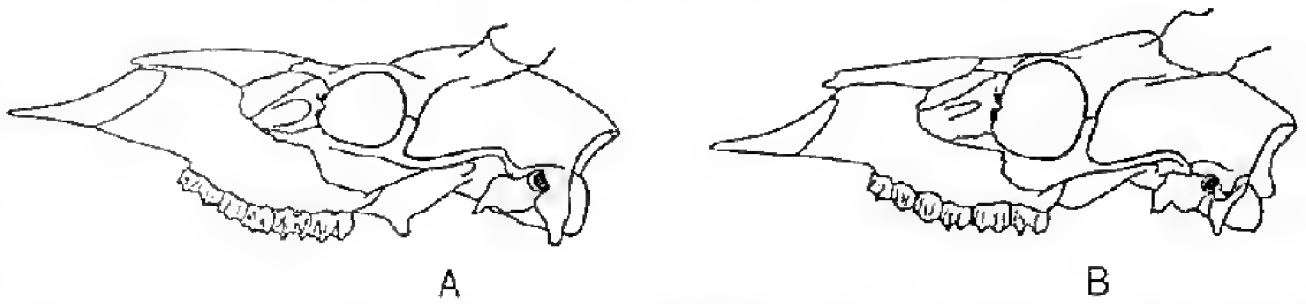

FIG. 62. Lateral views of skulls of two races of *Odocoileus hemionus* to show difference in shape. x ¾. A. *O. h. peninsulae,* male, adult, no. 43226, Mus. Vert. Zool., Laguna Valley, 6500 ft., Victoria Mountains, Lower California, Mexico. B. *O. h. fuliginatus,* type specimen.

For comparison with *cerrosensis* and additional comparison with *fuliginatus* see accounts of those races.

Molts.—*O. h. peninsulae* differs from all the other races studied in the seasonal retardation of the molts. The summer molt instead of taking place in June, as in the northern races, is accomplished at least a month later. Male and female specimens taken during the first three weeks of July at an altitude of 6000 feet are all in the winter pelage, though this is very brittle and in most specimens badly abraded. A corresponding retardation of the fall molt is evinced; specimens taken November 21, 1928, at an altitude of 4000 feet are in full summer pelage without any indication of wear, though the short new winter hair can be seen if one separates the hairs of the long summer coat. Another specimen, a female, taken at the same altitude on December 9, 1928, is in very short winter pelage with a large intermixture of summer hairs on the neck, sides and flanks. A single adult male in fresh winter

pelage taken on November 25, 1928, is the only specimen examined in which the molt is not obviously later than in northern races, and even in this instance it is possible that the molt was about a month later than the normal for other races of mule deer.

Antlers.—Lydekker (1897:899; 1898:276) describes this race as having simple spike antlers wtih a sub-basal snag. This seems to be an

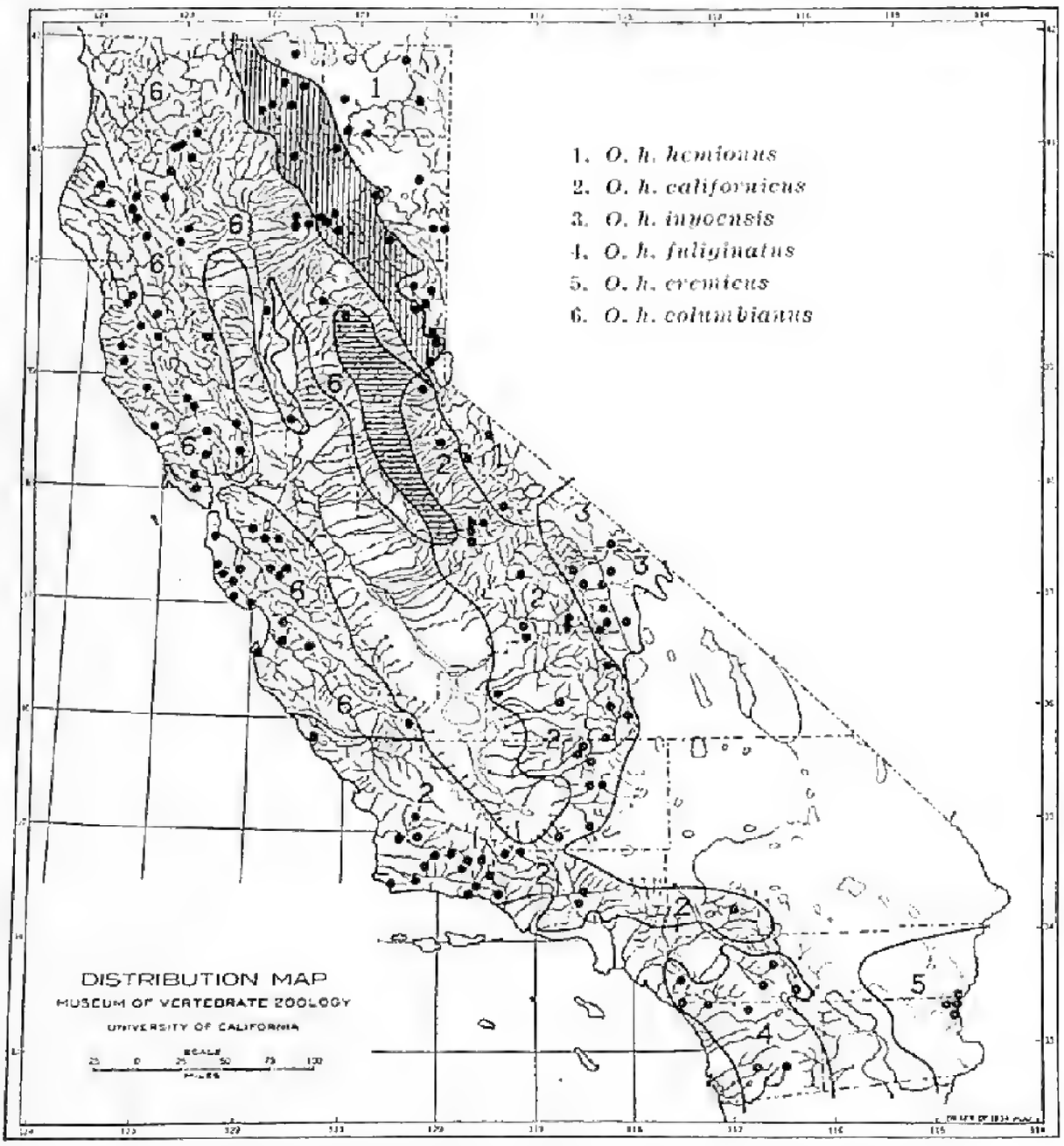

FIG. 63. Ranges of the subspecies of black-tail deer (*Odocoileus hemionus*) in California as determined from specimens examined. Note the "overlapping" of ranges as indicated by shaded areas where direct integradation between subspecies with adjoining ranges does not always occur.

error of interpretation as regards the form and size of the antler. His "sub-basal snag" was probably the branch a^2 of the forked antler and not a^1, the true sub-basal snag, which is never found on the spike antlers of immaturity and almost never on the forked antlers of immaturity. Both of Lydekker's specimens were subadults, and he did not have access to field notes of the expedition, which notes (Coolidge,

MS) indicate that at the type locality, adult males with normal antlers had been taken but not preserved.

Adult antlers of *peninsulae* are inseparable in point of size and form from those of *californicus*.

Remarks.—*O. h. peninsulae* is confined to the Upper and Lower Sonoran zones, in which it appears to frequent all types of habitats providing sufficient cover and water.

Lydekker (1898:276) states that this race was named on the basis of several skins of females and subadult males. His statement that the race was "* * * much smaller than the last [*O. h. californicus*] * * * with the antlers in the form of simple spikes and a basal snag" probably describes age rather than racial features. Even so, if the description be correct, it indicates animals abnormal to a degree not as yet encountered in any other race of *hemionus*. However, as outlined above, the error was probably one of interpretation. Caton (1876:468) fell into the same error, but he had not examined any specimens and was merely quoting the (verbal) report of Professor Baird concerning some specimens from Cape San Lucas, received by the Smithsonian Institution, but "destroyed soon afterward."

Lydekker later (1915:181) erroneously indicates the type to be the subadult male, British Museum no. 98.3.1.171; original number 210 of Dane Coolidge.

Specimens examined.—Total number, 10, all from Lower California, Mexico, as follows: Laguna Valley, Victoria Mts., 5 (M. V. Z.); El Sauce, Victoria Mts., 2 (M. V. Z.); Cape San Lucas, 1, and Santa Teresa Bay, 1, in the Donald R. Dickey Collection.

Odocoileus hemionus eremicus (Mearns)

Burro Deer

Dorcelaphus hemionus eremicus Mearns, Proc. U. S. Nat. Mus., 20, 1897:470.
Cervus macrotis, Cooper, Proc. Calif. Acad. Sci., 4, 1870:74; Woodhouse, Zool. in Sitgreaves Rept. Exp. down the Zuni and Colorado Rivers, 1853:40.
Mazama hemionus eremica, Lydekker, The Deer of All Lands, 1898:277.
Odocoilcus hemionus eremicus, Thompson, Forest and Stream, 51, 1898:286; Miller and Rehn, Proc. Boston Soc. Nat. Hist., 30, 1906:16; Stone and Cram, Amer. Animals, 1902:41; Stone, Proc. Acad. Nat. Sci. Phila., 57, 1905:680; Stephens, Calif. Mammals, 1906:50; Mearns, U. S. Nat. Mus. Bull. 56, 1907:208; Seton, Life Hist. of Northern Animals, 1909:119; Miller, U. S. Nat. Mus. Bull. 79, 1912:388; Grinnell, Proc. Calif. Acad. Sci., 3, 1913:368; Clarke, Calif. Fish and Game Comm. Bull. 1, 1913:10; Grinnell, Univ. Calif. Publ. Zool., 12, 1914:219; Lydekker, Cat. Ung. Mamm. Brit. Mus., 4, 1915:180; Nelson, Nat. Acad. Sci., 16, 1921:127; Miller, U. S. Nat. Mus. Bull. 128, 1924:485; Hall, Calif. Fish and Game, 13, 1927:245; McLean, Calif. Fish and Game, 16, 1930:119; Bailey, Nature Mag., 20, 1932:64; Grinnell, Univ. Calif. Publ. Zool., 40, 1933:208; Sheldon, Santa Barbara Mus. Nat. Hist. Occ. Papers, no. 3, 1933:18.
Odontocoelus hemionus eremicus, Elliot, Field Columb. Mus. Publ., Zool. ser. 4, 1904:77; Elliot, Field Columb. Mus. Publ., Zool. ser. 6, 1905:49.

Type.—Male, adult; skin (no skull); no. 63403, U. S. Nat. Mus.; Sierra Seri, near Gulf of California, opposite Tiburon Island, in the most arid portion of Sonora, Mexico; December, 1895; collected by Dr. W. J. McGee (Lyon and Osgood, 1909:13).

Range.—From the type locality northward into the valley of the Colorado River as far as Parker, Arizona, westward through the Chuck-

walla and Chocolate mountains, California, to near Coxcomb and Granite mountains in northern Riverside County (formerly northwest through Imperial Valley to Indio), and southward into northeastern Lower California, Mexico.

Measurements.—Male: Total length, 1680 mm.; tail, 190; hind foot, 491; ear from crown, 250; metatarsal gland, 129. Female: Total length, 1430; tail, 180; hind foot, 430; ear from crown, 218. (Stephens, 1906:51.)

Skull: Selected cranial measurements of 4 adult males from California and Arizona are: Basilar length of Hensel, 276 (274–277) mm.; nasal length, 85 (75–99); greatest width of nasals, 35 (32–42); least interorbital width, 82 (80–85); zygomatic width, 125 (116–130); mastoid width, 89 (79–93); upper molar series, 83 (81–85); lower molar series, 94 (92–97); palatal breadth, 56 (55–57); length of external nares, 80 (79–81); width of external nares, 42 (39–44); diastema, 75 (67–81).

External comparisons.—*O. h. eremicus* differs from *hemionus* in having dorsal surface much lighter colored, more grayish yellow than dusky or dusky brown; rump patch more restricted; axillae buff rather than white; brisket paler; inguinal region naked rather than haired; belly and inside of thighs washed with buff, rather than white; brow patch darker and more definite, having distinct V-shaped area of Fuscous between and anterior to eyes.

From *inyoensis, eremicus* differs as follows: Lighter in color; no white stripes from abdomen to axillae; white spot on throat present, but neither as definite nor extensive; metatarsal gland generally longer.

O. h. eremicus can be differentiated from *fuliginatus* by larger size; absence of dark dorsal stripe; lighter color throughout; and by having dark markings on lower lip restricted, and not meeting on mid-line ventrally, rather than extensive and meeting ventrally on mid-line of chin.

O. h. eremicus differs from *O. h. canus* in larger size; longer metatarsal gland; markedly darker (less gray) coloration of dorsal surface; tail always without, rather than sometimes with, dark mid-dorsal stripe; brow patch dark and with well defined anterior V-shaped mark, rather than scarcely differentiated from rest of dorsal surface; brown spots at base of rhinarium large and well defined rather than reduced.

Skull: Characterized by possession of very heavy dentition. As compared with *hemionus* from Modoc County, California, *eremicus* has orbital width averaging actually and relatively less; mastoid width generally less than, rather than generally greater than, 90 mm.; upper maxillary tooth row longer and heavier; generally greater than, rather than generally less than, 80 mm. and averaging 100 per cent rather than 92 per cent of least interorbital width. Third upper molar longer and wider, greatest width times greatest length, at gum-line, always greater than, rather than always less than, 280 mm.

The same dental distinctions apply in comparison with *inyoensis* from which *eremicus* differs further as follows: Size much larger in every measurement taken; mastoid width greater than, rather than generally less than, orbital width; palatal width greater than 54 mm. rather than generally less than 50 mm.; length of lower molar series

greater than, rather than less than, 90 mm.; diastema averaging 15 mm. greater, 75 mm. as against 60 mm.

O. h. eremicus is distinguished from *canus* by larger size throughout; diastema 73 per cent or more as against 70 per cent or less, of lower molar series; palatal breadth 22 per cent rather than 20 per cent of basilar length of Hensel.

Antlers.—Mearns (1897:470; 1907:209) stated that the antlers of this race were characterized by the remarkable length of the beam before forking and gave measurements of two sets slightly larger than ones I have examined. Comparison of measurements on tables G and D will show that, on the contrary, the antlers of *eremicus* are slightly shorter between the corona and primary fork than in *hemionus*. The ratio of this distance to the greatest length of the beam around the curve, is 54 per cent in the former, and 53 per cent in the latter. This is a difference of no significance in such variable structures as antlers. The antlers of *eremicus*, therefore, are found to be indistinguishable from those of *hemionus*.

Remarks.—This deer occurs in the Lower Sonoran Zone, chiefly below the 1500-foot level. It inhabits the river bottom lands, where the chief vegetation is willow, mesquite, screwbean and arrowweed, and the desert washes provided with ironwood and paloverde trees. Also it is found sparingly in the desert mountain ranges wherever suitable vegetation and water are available.

When the animal was first named, no complete skulls were available, and the well marked cranial characters have not until now been described.

The only races with ranges adjoining that of *eremicus* are *canus* on the east and *fuliginatus* on the west. Each of these is so distinct from *eremicus*, as regards both cranial and external characters, as to offer little or no difficulty when racial identifications are attempted.

No actual intergrades between *eremicus* and *fuliginatus* or *eremicus* and *canus* (found as far west as the Huachuca Mountains of Arizona [Mearns, 1907:191]) have been seen, although intergrades are expectable.

TABLE G

Antler Measurements of *Odocoileus hemionus eremicus*

Museum number	*Corona to primary fork	*Corona to tip of anterior prong	*Primary fork to posterior secondary fork	*Primary fork to anterior secondary fork	*Circumference 1 inch above corona	Spread at primary fork	Greatest outside spread	Greatest tip to tip spread
23678	254	532	123	124	112	462	655	610
47216	253	564	175	------	126	537	602	493
44386	310	602	156	------	109	545	615	525
Average	304	566	151	124	116	511	624	543

* All measurements are in millimeters; of the left antler, taken around the outside of the curve.

Specimens examined.—Total number, 6. Unless otherwise indicated, specimens are in the Museum of Vertebrate Zoology.

Mexico: Sierra Seri, 1[a]; Tiburon Island, 1[b].

Arizona: Colorado River opposite Blythe, Riverside Co., Calif., 1.

California: Colorado River 25 mi. S Blythe, Riverside Co., 1; 6 mi. SW Palo Verde, Imperial Co., 1; 5 mi. S Palo Verde, Imperial Co., 1.

Odocoileus hemionus cerrosensis Merriam

Cedros Island Deer

Odocoileus cerrosensis Merriam, Proc. Biol. Soc. Wash., 12, 1898:101; Miller and Rehn, Proc. Boston Soc. Nat. Hist., 30, 1901:14; Stone and Cram, Amer. Animals, 1903:41; Miller, U. S. Nat. Mus. Bull. 79, 1912:387; Nelson, Nat. Acad. Sci., 16, 1921:130; Miller, U. S. Nat. Mus. Bull. 128, 1924:486.

Mazama hemionus cerrosensis, "Lydekker, Great and Small Game of Europe * * *, 1901:359."

Odocoileus hemionus cerrosensis, Lydekker, Cat. Ung. Mamm. Brit. Mus., 4, 1915:180; Bailey, Nature Mag., 20, 1932:64.

Odontocoelus cerrosensis, Elliot, Field Columb. Mus. Publ., Zool. ser., 4, 1904:76; Elliot, Field Columb. Mus. Publ., Zool. ser., 6, 1905:47.

Type.—Male, adult; skin and skull, no. 80782, U. S. Nat. Mus., Biol. Surv. Coll.; taken on Cerros (or Cedros) Island, off the western coast of Lower California, Mexico; August 9, 1896; collected by A. W. Anthony.

Range.—Confined to Cedros Island where it inhabits the brush lands of the northern part and the few areas suitable on the southern part of the island.

Measurements.—Externals: Measurements of adult male type, taken from dry skin: Total length, 1560 mm.; tail, 180; hind foot, 380; ear from crown anteriorly, 180; length of metatarsal gland (3 specimens), 72 (59–97).

Skull: Measurements of a young male: Basilar length of Hensel, 213 mm.; nasal length, 76; greatest width of nasals, 29; orbital width, 66; zygomatic width, 94; mastoid width, 66; upper molar series, 68; lower molar series, 76; palatal breadth, 44; postpalatal breadth, 26; length of external nares, 53; width of external nares, 25; diastema, 57; width of Pm^2, 8; elevation of rostrum, 33.

Measurements of two adult females are: Basilar length of Hensel, 217 mm.; nasal length, 78 (77–78); greatest width of nasals, 28; orbital width, 63 (62–63); zygomatic width, 95 (94–96); mastoid width, 67 (66–67); upper molar series, 65 (62–67); lower molar series, 77 (76–78); palatal breadth, 45 (44–45); post palatal width, 27 (26–28); length of external nares, 58 (57–58); width of external nares, 27 (26–28); diastema, 61 (60–61); width of Pm^2, 9; elevation of rostrum, 38 (37–39).

External comparisons.—*O. h. cerrosensis* differs externally from all other races on the Pacific Coast in the extreme paleness of the summer pelage; in the presence of a pronounced dorsal line in the summer pelage; in the absence of a white rump patch in both summer and winter pelage; in having all areas usually white, washed with buffy brown; and excepting from *columbianus* in smaller size.

[a] Coll. D. R. Dickey.
[b] U. S. Nat. Mus.

Cranial comparisons.—*O. h. cerrosensis* differs from *peninsulae* in the following respects: Skull smaller in all parts measured, with relatively as well as actually shorter tooth row, and individual teeth averaging narrower. Rostrum not markedly elevated anteriorly. Besides being smaller in all parts measured, *cerrosensis* differs cranially from *fuliginatus* in the following selected respects: Mastoid width equal to or greater than orbital width; upper and lower molar series relatively shorter; elevation of rostrum averaging greater.

Molt.—A subadult specimen taken on August 7 is in well grown fresh winter pelage with some of the old hairs of the summer coat still clinging to the sides. Two other specimens taken on August 7 and 13 are in the summer pelage. Probably, therefore, the autumnal molt normally occurs in the month of September as it does in *californicus* and the other races of the genus inhabiting California.

Antlers.—When Merriam named *cerrosensis*, he evidently had seen no perfect antlers of fully adult animals, for he describes them as branching once only. Specimens now in the collection of the California Academy of Sciences show, however, that the antlers are of the same doubly dichotomous type as in other races of *O. hemionus*. None of the antlers that I have examined had a basal snag present; probably it does not occur at all in the small antlers of this insular race. In a young adult possessing the permanent dentition the antlers are represented by a short knob just breaking the surface of the skin on one side, and by an antler approximately one inch in length on the other side. In another specimen of the same age, from which the antlers have been removed, pedicels are so small as to make me almost certain that the antlers were very short spikes. At a corresponding age the northern races of the genus would have antlers of the forked type at least. The accompanying table presents the measurements of three doubly dichotomous antlers of this race.

TABLE II

Measurements of Antlers of *Odocoileus hemionus cerrosensis*

Museum number, all California Acad. Sci.	*Corona to primary fork	*Corona to tip of anterior prong	*Primary fork to posterior secondary fork.	*Primary fork to anterior secondary fork	*Circumference one inch above corona	Greatest outside spread	Greatest tip to tip spread
4670	155	414	157	127	94	400	348
4678	176	445	100	101	88	------	------
4680	190	------	97	100	107	------	------
Average	174	429	108	109	96	400	348

* Measurements are those of the left antler.
All measurements are in millimeters.

Remarks.—The deer of Cedros Island differs from those of the mainland principally in smaller size. In certain characters, such as elevation of rostrum, *cerrosensis* is intermediate between *fuliginatus* and *peninsulae*. A comparison of all the characters of the race, however,

shows it to be closer to *fuliginatus* than to *peninsulae*. The small size of the rump patch, the tendency to have the underparts washed with buff, and the black stripe down the dorsal surface of the tail are among the most prominent of the characters possessed by *cerrosensis* that would suggest an origin from a type resembling *fuliginatus*.

Specimens examined.—Four, and 4 sets of antlers, all from Cedros Island and preserved at the California Academy of Sciences.

LITERATURE CITED

Allen, G. M.
1901. The Louisiana deer. Am. Nat., *35:* 449–454, 3 figs.

Allen, J. A.
1902. Zimmermann's 'Zoologiae Geographicae' and 'Geographische Geschichte' considered in their relation to mammalian nomenclature. Bull. Am. Mus. Nat. Hist. *16:* 13–22.

Audubon, J. J., and Bachman, J.
1851. The quadrupeds of North America, *2:* 1–334, 49 pls.

Bailey, V.
1931. Mammals of New Mexico. U. S. Dept. Agr., Bur. Biol. Surv., N. Am. Fauna, no. 53: 1–412, 22 pls., 58 figs.
1932a. Blacktail and mule deer. Nature Mag., *20*, no. 2: 61–64, 6 figs., 1 map.
1932b. The northwestern white-tail deer. Proc. Biol. Soc. Wash., *45:* 43–44.
1933. The white-tailed deer. Nature Mag., *21*, no. 3: 123–126, 5 figs., 1 map.

Baird, S. F.
1857. Mammals, in, Reports of explorations and surveys to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean. U. S. Pac. R. R. Exp. and Surv., *8:* XLVIII+1–737, 60 pls., 35 figs.
1859. Mammals of the boundary, in, Emory's United States and Mexican boundary survey, *2*, pt. 2: 1–62, 27 pls.

Bendire, C.
1882. On the eastward distribution of the black-tailed deer (*Cariacus columbianus*). Proc. U. S. Nat. Mus., *5:* 348–349.

Boetticher, H. V.
1915. Untersuchung uber der Zusammenhang zwischen Klima und Korpergrosse der homoothermen Tiere. Zool. Jahrbuch, *40:* 1–56.

Borell, A. E., and Ellis, R.
1934. Mammals of the Ruby Mountains region of northeastern Nevada. Jour. Mammalogy, *15*, no. 1: 12–44, 6 pls.

Brooke, V.
1878. On the classification of the Cervidae, with a synopsis of the existing species. Proc. Zool. Soc., London, 1878: 883–928, 1 pl., 19 figs.

Brooks, A.
1907. Deer of British Columbia. Canadian Mag., *29:* 537–542, 7 figs.
1926. Past and present big-game conditions in British Columbia and the predatory animal question. Jour. Mammalogy, *7*, no. 1: 35–40.

Bryant, W. E.
1891a. A provisional list of the land mammals of California. Zoe, *1*, no. 12: 353–360.
1891b. Notes on the land mammals of California. Zoe, *2:* 112–114.
1892. Recent additions to the North American land mammal fauna. Zoe, *3:* 201–223.

Burt, W. H.
1934. The mammals of southern Nevada. Trans. San Diego Soc. Nat. Hist., *7*, no. 36: 375–428, 1 map.

Cassin, J.
1858. Mammalogy and ornithology. U. S. Expl. Exped., *8:* VIII+446.

Caton, J. D.
1876. A new Californian deer. Am. Nat., *10:* 464–469.
1877. The antelope and deer of America. 1st edition, New York, Hurd and Houghton, XVI+17–426.
1885. The mule deer in domestication. Am. Nat., *19:* 811–812.

Clarke, F. C.
1913. Investigation of the large game situation in California with special reference to the deer. Game Bull. no. 1, Calif. Fish and Game Comm., 6–20.
1916. Malformed antlers of deer. Calif. Fish and Game, 2, no. 3: 119–123, 4 figs.

Clarke, F. I.
1910. Game animals, birds and fishes of British Columbia. Bureau of Prov. Inform., Bull. 17, (6th. ed.): 1–67, 23 pls.

Cooper, J. G.
1869. The naturalist in California. Am. Nat., *3:* 182–189.

Cooper, J. G., and Suckley, G.
1859. Natural History of Washington Territory, in, Survey of the North Pacific Railroad Route Territory, part 2, Report on the mammals collected on the Survey., 73–139, 6 pls.

Coues, E.
1893. History of the expedition under the command of Lewis and Clark. 4 vols., New York, Francis P. Harper.

Cowan, I. McT.
1933a. A new race of deer from eastern California. Proc. Biol. Soc. Wash., *46:* 69–70.
1933b. The mule deer of southern California and northern Lower California as a recognizable race. Jour. Mammalogy, *14:* 326–327.

Douglas, D.
1829. Observations on two undescribed species of North American mammalia (*Cervus leucurus* et *Ovis californianus*). Zool. Journ., 4: 330–332.
1914. Journal kept by David Douglas during his travels in North America 1823–1827. London. W. Wesley and son, 1–364.

Dixon, J. S.
1927a. Horned does. Jour. Mammalogy, *8:* 289–291, 2 pls.
1927b. The white-tailed deer in California. Jour. Mammalogy, *8:* 308.
1934. A study of the life history and habits of mule deer in California. Part 1, Calif. Fish and Game, *20:* 182–282.

Elliot, D. G.
1899. Catalogue of mammals from the Olympic mountains of Washington with descriptions of new species. Field Columb. Mus. Zool. Ser., *1*, no. 13: 241–276, 15 figs., 20 pls.
1901. A synopsis of the mammals of North America and the adjacent seas. Field Columb. Mus. Zool. Ser., *2:* XV+1–471.
1903. A list of mammals obtained by Edmund Heller collector for the museum from the coast region of northern California and Oregon. Field Columb. Mus. Zool. Ser., *3:* 175–197.
1904a. Catalogue of mammals collected by Edmund Heller in southern California. Field Columb. Mus. Zool. Ser., *3*, no. 16: 269–321, pls. 38–49, 1 map.
1904b. The land and sea mammals of Middle America and the West Indies. Field Columb. Mus. Zool. Ser., *4:* XXI+1–439+XLIX, 51 pls., 82 figs., 58 figs. in text.
1905. A check list of mammals of the North American continent, the West Indies and the neighboring seas. Field Columb. Mus. Zool. Ser., *6:* V+1–761, 1 pl.

Ferris, G. F.
1916. A catalogue and host list of the Anoplura. Proc. Calif. Acad. Sci., 4th ser., *6:* 129–213.

Fitzinger, L. J.
1873. Die Gattungen der Familie der Hirsch (Cervi) nach ihrer naturlichen Verwandtschaft. Sitzungsberichte der mathematisch-naturwissenschaftlichen Classe der k. Akademie der Wissenschaften, *68*, pt. 1, 332–362.
1879. Kritische Untersuchungen uber die Arten der naturlichen Familie der Hirsche (Cervi). 3 Abt., Sitzungsberichte der mathematisch-naturwissenschaftlichen Classe der k. Akademie der Wissenschaften, *78:* 301–376.

Fowler, G. H.
1894. On variation in the antlers of the fallow deer. Proc. Zool. Soc., London, 1894: 485–494.

Gadow, H.
1902. The evolution of horns and antlers. Proc. Zool. Soc., London, 1902, No. 1: 206–222, 1 fig.

Garrod, A. H.
1877. Notes on the visceral anatomy and osteology of the ruminants, with a suggestion regarding a method of expressing the relations of species by means of formulae. Proc. Zool. Soc., London, 1877: 2–18, 25 figs.

Gaskoin, J. S.
1856. On some defects in the growth of antlers, and some results of castration, in the Cervidae. Proc. Zool. Soc., London, 1856: 150–159, 3 figs.

Gegenbaur, C.
1867. Ueber die Bildung des Knochengewebes. Jenaische Zeitschrift fur Medicin und Naturwissenschaft, *3:* 206–246, 2 pls.

Gosnell, R. E.
1911. Yearbook of British Columbia. Coronation edition, 1–358, illustr.

Gray, J. E.
1850. Synopsis of the species of deer (Cervina), with the description of a new species in the gardens of the society. Proc. Zool. Soc., London, 1850: 222–242, 7 pls.
1866. On the long-eared deer or mule deer of North America (Eucervus). Annals and Mag. Nat. Hist., Ser. 3, *18:* 338–339.
1872. Catalogue of the ruminant mammalia in the British Museum. London (Taylor and Francis), VIII+102, 4 pls. inserted.
1873. Hand-list of the edentate, thick-skinned and ruminant mammals in the British Museum. London (E. Newman), VII+176, 42 pls.

Grinnell, J.
1908. The biota of the San Bernardino mountains. Univ. Calif. Publ. Zool., *5:* 1–170, 24 pls.
1913. A distributional list of the mammals of California. Proc. Calif. Acad. Sci., *3:* 265–390, 2 pls.
1914. An account of the mammals and birds of the lower Colorado valley with especial reference to the distributional problems presented. Univ. Calif. Publ. Zool., *12:* 51–294, 10 pls., 9 figs.
1923. A systematic list of the mammals of California. Univ. Calif. Publ. Zool., *21:* 313–324.
1933. Review of the Recent mammal fauna of California. Univ. Calif. Publ. Zool., *40:* 71–234.

Grinnell, J., and Swarth, H. S.
1913. An account of the birds and mammals of the San Jacinto area of southern California with remarks on the behavior of geographic races on the margins of their habitats. Univ. Calif. Publ. Zool., *10:* 197–406, 7 pls., 3 figs.

Grinnell, J., and Storer, T. I.
1924. Animal life in the Yosemite. Berkeley, University of California Press, XVIII+752, 60 pls., 2 maps, 65 figs.

Grinnell, J., Dixon, J., and Linsdale, J. M.
1930. Vertebrate natural history of Lassen Peak region. Univ. Calif. Publ. Zool., *35:* V+594, 139 figs., 43 maps and graphs.

Hall, E. R.
1927. The deer of California. Calif. Fish and Game, *13:* 223–259, 13 figs.

Hall, F. S.
1932. A historical resume of exploration and survey—mammal types and their collectors in the State of Washington. The Murrelet, *13:* 62–91, 1 pl.

Harlan, R.
1825. Fauna Americana. Philadelphia, A. Finley, X+320.

Heape, W.
1931. Emigration, migration and nomadism. Cambridge, W. Heffer and Sons, Ltd., XII+369, illustr.

Heller, E.
1909. The mammals, in, Birds and mammals of the 1907 Alexander expedition to southeastern Alaska. Univ. Calif. Publ. Zool., *5:* 245–264, 1 pl., 2 figs.

Henshaw, H. W.
1876. Notes on mammals taken and observed in California in 1875. App. H.12, in, Ann. Rept. Geograph. Surv. west of the 100th merid. (Wheeler), 305–312.

Holding, R. E.
1897. Horns of fallow deer showing malformations. Proc. Zool. Soc., London, 1897: 189–190.

Hornaday, W. T.
1907. The national collection of heads and horns. Part 1, New York Zoological Society, 1–39, 8 pls.

Holzworth, J. M.
1930. The wild grizzlies of Alaska. New York and London, G. P. Putnam's Sons, XXI+417, 84 pls.

Hunter, J. S.
1924. Deer hunting in California. Calif. Fish and Game, *10:* 18–23.

Huxley, J. S.
1932. Problems of relative growth. London, Methuen and Co., Ltd., XIX+276.

Jackson, H. H. T.
1921. A hybrid deer of the F_2 generation. Jour. Mammalogy, *2:* 140–143, 1 pl.

Jewett, S. G.
1914. The white-tailed deer and other deer in Oregon. The Oregon Sportsman, 2, no. 8: 5–9, 1 pl., 2 figs.

Kellogg, L.
1916. Report on mammals and birds found in portions of Trinity, Siskiyou and Shasta counties, California. Univ. Calif. Publ. Zool., *12:* 335–398, 4 pls.

Loomis, F. B.
1925. Dentition of artiodactyls. Bull. Geol. Soc. Amer., *36:* 583–604, 20 figs.
1928. Phylogeny of the deer. Amer. Jour. Sci., 5th series, *16:* 531–542, 10 figs.

Lord, J. K.
1866. The naturalist in Vancouver Island and British Columbia. London, R. Bentley, *2:* X+1–375.

Lydekker, R.
1897. On a new mule-deer. Proc. Zool. Soc., London, 1897: 899–900.
1898. The deer of all lands. London, R. Ward, XX+329, 24 pls., 80 figs.
1915. Catalogue of the ungulate mammals in the British Museum, *4:* XXI+438, 56 figs.

Lyon, M. W., and Osgood, W. H.
1909. Catalogue of the type specimens of mammals in the United States National Museum, including the Biological Survey collection. U. S. Nat. Mus. Bull. 62: IX+325.

McLean, D. D.
1930. The burro deer in California. Calif. Fish and Game, *16:* 119–120.
1931. White-tailed deer in California. Calif. Fish and Game, *17:* 342.

Macewen, W.
1920. The growth and shedding of the antler of the deer. Glasgow, Maclehose, Jackson and Co., XVII+109.
1923. The antlers of the deer and its relation to the growth of bone. Brit. Medic. Jour., *2:* 91–93.

Maillard, J.
1927. Birds and mammals of Modoc County, California. Proc. Calif. Acad. Sci., *16*, ser. 4: 261–359, 1 fig.

Mearns, E. A.
1897. Preliminary diagnosis of new mammals of the genera *Mephitis*, *Dorcelaphus* and *Dicotyles* from the Mexican border of the United States. Proc. U. S. Nat. Mus., *20:* 467–471.
1907. Mammals of the Mexican boundary of the United States. U. S. Nat. Mus. Bull. 56, part 1: XV+530, 13 pls., 126 figs.

Merriam, C. H.
1898. The earliest generic name for the North American deer, with descriptions of five new species and subspecies. Proc. Biol. Soc. Wash., *12:* 99–104.
1899. Results of a biological survey of Mount Shasta, California. N. Am. Fauna 16, U. S. Dept. Agr., Bur. Biol. Surv., 1–135, 5 pls., 46 figs.

Miller, G. S.
1912. List of North American land mammals in the United States National Museum, 1911. U. S. Nat. Mus. Bull. 79: XIV+455.
1924. List of North American recent mammals. U. S. Nat. Mus. Bull. 128: XVI+673.

Miller, G. S., and Rehn, J. A. G.
1903. Systematic results of the study of North American land mammals during the years 1901 and 1902. Proc. Boston Soc. Nat. Hist., 31: 61–145.

Modell, W., and Noback, C. V.
1931. Histogenesis of bone in the growing antler of the Cervidae. Amer. Jour. Anat., *49:* 65–86, 2 figs., 4 pls.

Moffitt, J.
1934a. Mule deer study program. Calif. Fish and Game, *20:* 52–65.
1934b. Another new deer from California. Calif. Fish and Game, *20:* 81.
1934c. Sheldon's Deer of California. Calif. Fish and Game, *20:* 85–87.

Muller, J.
1843. Elements of Physiology. Trans. from the German by W. Baly, Philadelphia, Lea and Blanchard, XIX+886.

Nelson, E. W.
1921. Lower California and its natural resources. Nat. Acad. Sci., *16:* 1–194, 35 pls.

Noback, C. V., and Modell, W. S.
1930. Direct bone formation in the antler tines of two of the American Cervidae, Virginia deer (*Odocoileus virginianus*) and wapiti (*Cervus canadensis*). Zoologica, *11:* 19–60, 56 figs.

Ogilby, W.
1840. Monograph on the hollow-horned ruminants. Proc. Zool. Soc., London, 1840: 4–10.

Osgood, W. H.
1908. The game resources of Alaska. Yearbook Dept. Agr. for 1907: 460–482, 2 pls., 3 figs.

Parker, W. K.
1874. On the structure and development of the skull in the pig (*Sus scrofa*). Philos. Trans. Royal Soc., London, *164:* 289–336, 10 pls.

Peale, T. R.
1848. Mammalia and ornithology of the United States exploring expedition during the years 1838, 1839, 1840, 1841 under the command of Charles Wilkes, U. S. N., *8:* XV+338.

Pocock, R. I.
1910. On the specialized cutaneous glands of ruminants. Proc. Zool. Soc., London, 1910: 840–986, 59 figs.
1912. On antler-growth in the Cervidae, with special reference to *Elaphurus* and *Odocoileus* (*Dorcelaphus*). Proc. Zool. Soc., London, 1912: 773–783, 5 figs.
1933. Homologies between the branches of the antlers of the Cervidae based on the theory of dichotomous growth. Proc. Zool. Soc., London, 1933: 377–406, 13 figs.

Rafinesque, C. S.
1817. Extracts from the journal of Mr. Charles LeRaye, relating to some new quadrupeds of the Missouri region. Am. Monthly Mag., *1:* 435–436.

Rensch, B.
1929. Das prinzip geographischer Rassenkreise und das problem der Artbildung. Berlin, Gebruders Borntraeger, 1–206, 27 figs.
1933. Kurze anweisung fur zoologische-systematische studien. Akad. Verlagsgesellschaft. M.B.H., Leipzig, 1–116, illustr.

Richardson, J.
1829. Fauna Boreali-Americana. *1:* XLVI+300, 24 pls.

Ridgway, R.
1912. Color standards and color nomenclature. Washington, D. C., IV+44.

Robin, C., and Herrman.
1882. Memoire sur la generation et regeneration de l'os des cornes caduques et persistentes des ruminants. Jour. d'Anat. et de Physiol., *18:* 205–265.

Rorig, A.
1899. Welche Beziehungen bestehen den Reproduktionsorganen der Cerviden und der Geweihbildung derselben? Archiv. fur Entwickelungsmechanik der Organismen, *8:* 382–447.

Say, T.
1823. In, James' Account of an expedition from Pittsburgh to the Rocky Mountains, under the command of Major Stephen H. Long. Philadelphia, H. C. Carey and Lea, *2:* XCVIII+1–442.

Schinz, H.
1844. Systematisches Verzeichniss aller bis jetzt bekannten Saugethiere. Solothurn: Jent und Gassmann, *1:* XVI+574.

Seton, E. T.
1909. Life histories of northern animals. New York, C. Scribner's Sons, *1:* XII+1–673.
1929. Lives of game animals. Doubleday, Doran and Co., *3*, part 1: XIX+412, 110 pls., 10 maps.

Sheldon, C.
1912. The wilderness of the north Pacific coast islands. New York, C. Scribner's Sons, 1–246+XVI, illustr.

Sheldon, W. G.
1932. Mammals collected or observed in the vicinity of Laurier Pass, B. C. Jour. Mammalogy, *13:* 196–203.

Sheldon, H. H.
1933. The deer of California. Santa Barbara Mus. Nat. Hist. Occ. Papers, no. 3: 1–71, 15 pls., 23 figs., 1 map.

Skinner, M. P.
1921. Horn shedding in Yellowstone Park. Jour. Mammalogy, *2:* 172–173.

Stephens, F.
1906. California mammals. San Diego, West Coast Publishing Co., 1–351, 7 pls., 23 figs., 1 map.
1921. An annotated list of the mammals of San Diego County, California. Trans. San Diego Soc. Nat. Hist., *3*, no. 3: 41–56.

Stone, W.
1904. On a collection of birds and mammals from Mt. Sanhedrin, California. Proc. Acad. Nat. Sci. Phila., *56:* 576–591.
1905. On a collection of birds and mammals from the Colorado delta, Lower California. Proc. Acad. Nat. Sci. Phila., *57:* 676–690.

Swarth, H. S.
1911. Birds and mammals of the 1909 Alexander Alaska Expedition. Univ. Calif. Publ. Zool., *7:* 9–172, 6 pls., 3 figs.
1912. Report on a collection of birds and mammals from Vancouver Island. Univ. Calif. Publ. Zool., *10:* 1–124, 4 pls.
1922. Birds and mammals of the Stikine River region of northern British Columbia and southeastern Alaska. Univ. Calif. Publ. Zool., *24:* 125–314, 8 pls., 34 figs.

Taylor, W. P.
1916. The status of the beavers of western North America, with a consideration of the factors in their speciation. Univ. Calif. Publ. Zool., *12:* 413–495, 15 figs.

Taylor, W. P., and Shaw, W. T.
1927. Mammals and birds of Mount Rainier National Park. Washington, D. C., 1–117.
1929. Provisional list of land mammals of the State of Washington. Occ. Papers of the Chas. R. Conner Mus., no. 2: 1–32.

Thompson, E. S.
1898. A list of the big game of North America. Field and Stream, *51:* 285–286, 4 figs.

Thwaites, R. G.
1904. Original journals of the Lewis and Clark Expedition. New York, Dodd, Mead and Co., *3:* X+363; *4:* X+372, illustr.

Townsend, C. H.
1887. Field notes on the mammals, birds and reptiles of northern California. Proc. U. S. Nat. Mus., *10:* 159–253, 1 pl.

Tyrrell, J. B.
1888. The mammalia of Canada. Excerpt from, Proc. Canadian Inst., April 7, 1888: 1–28.

True, F. W.
1884. A provisional list of the mammals of North and Central America, and the West Indian islands. Proc. U. S. Nat. Mus., *7:* 587–611.

VanDyke, T. S.
1902. The deer and elk of the Pacific coast. In, Roosevelt's, The deer family. New York, Macmillan Co., XII+1–334, illustr.

Wagner, J. A.
1844. Schreber's Die Saugethiere, suppl. *4:* XII+523.

Walsingham, T. L.
1873. On the distribution of the different species of deer and other ruminants in northern California and Oregon. Proc. Zool. Soc., London, 1873: 561–563.

Ward, R.
1903. Records of big game. London, Rowland Ward, Ltd., XIII+1–495, illustr.

Weber, M.
1888. Ueber neue Haut-Secrete bei Saugethieren. Archiv. fur Mikroscop. Anat., *31:* 499–540, 1 pl.
1927. Die Saugetiere, 2nd edit., Jena, Gustav Fischer, *1:* XV+1–444, 316 figs.

Wilhelm, J. von
1924. Zur Entwicklungsgeschichte der Hinterhauptsschuppe des Rindes. Anat. Anz., *59:* 1–11, 7 figs.

Williams, A. B.
1925. Game trails in British Columbia. New York, C. Scribner's Sons, XIV+ 1–360, 59 pls.

Williams, M. B.
1928. Jasper National Park. Dept. of Interior, Ottawa, 1–176, illustr.

Williams, M. Y.
1933. Fauna of the former dominion Peace River block, British Columbia. Report of the Prov. Mus. Nat. Hist., 1933: 14–24, 3 pls.

Woodhouse, S. W.
1853. Zoology, Mammals, in, Sitgreaves', Report of an expedition down the Zuni and Colorado rivers. Washington, D. C., 40–57.

Zawadowsky, M.
1926. Bilateral and unilateral castration in *Cervus dama* and *Cervus claphus*. Trans. Lab. Exp. Biol. of the Zoopark of Moscow, *1:* 18–48.

CALIFORNIA FISH AND GAME

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The first and most important requisite in planning for the conservation of a species is a knowledge of its life history. In so far as concerns California deer, the Bureau of Game Conservation is favored. A masterful study of the life history and food habits of the mule deer in California by Joseph S. Dixon, is now followed by an equally important paper on the distribution and variation in deer of the Pacific coastal region by Ian McTaggart Cowan.

Hunters generally seem to react favorably toward at least some of the elementary principles of conservation. No one would now propose that protection be removed from does or fawns. When one of these same men picks up his fishing rod, he too often seems to forget what he has learned about game mammals and birds. He wants to fish at all seasons for trout, he wants to take the adult steelheads without limit or distinction between sexes, he wants to take the young regardless of age or size. He forgets that a sizable steelhead is older than a three prong buck and that the little stream trout is a baby steelhead.—*J. O. S.*

TRAWLER INVESTIGATIONS, STATION LINE

In October of 1935 there was inaugurated by the Division a station line run of drags to determine the distribution of species and sizes of flatfish by depth, bottom and season in order to ascertain the effectiveness of the present regulations and to collect material for other studies. In the station line, drags with uniform gear (1½″ drag net) for a stated time are made at 10, 20, 30, 40, 50, and 100 fathoms on a line W. ¾ S. of Point Bonita light (the widest spot on the continental shelf in the state). This line will be run once a month for a year. Already we have four months' data and from preliminary analysis, the material points to the fact that small immature flatfish are more abundant in water deeper than 20 fathoms than in shallower water. If the preliminary results hold true throughout the work, the question will arise as to the usefulness and effectiveness of the present regulation that requires all drag boats to operate outside the 3 mile limit north of Pigeon Point. Perhaps it would be better to have a minimum size mesh for drag nets and allow trawl fishing in all northern California ocean waters. This type of regulation would save almost all small flatfish regardless of where fishing was done, whether in deep or shallow water, and would simplify the patrol of drag net fishing considerably. The question arises, if the 3 mile law on drag nets were abolished, of what effect inshore dragging would have on other bottom life such as crabs. Obser-

vations made while fishing with a drag net from the Division's boats (some 114 drags) and on commercial drag boats have never revealed a mutilated or crushed crab, regardless of size, sex or time of year, taken in a drag net nor have we ever seen a completely soft shelled crab taken by one of these nets. The catch of crabs by commercial drag nets has always been but a small percentage of the total take, 1 to 2 per cent yearly, so that even though shallow waters are allowed to be fished by drag nets they will take only a small number of crabs and many of these in deeper water than the crab fishermen operate.—*G. H. C., April 23, 1936.*

COOPERATIVE TESTS ON MESH SIZE

The San Francisco operators of paranzella drag nets are cooperating with the Division in making additional tests of mesh size in drag nets in order to determine the mesh size and parts of a drag net that will best liberate the small and immature fish found on the ocean bottom.

Two paranzella nets are being constructed by the operators, one of 1½″ mesh, furnished by the Division, the other of 5″ mesh, furnished by the operators. These nets will be fished by the commercial drag boats in special tests, either in alternate hauls or fishing with two sets of boats side by side on the same grounds, to test escapement and retention of small fish through the various parts of the net and to test the size of mesh which will allow the greatest escapement of small immature fish and at the same time retain the marketable sizes. The work will be done under the supervision of a Division investigator who will accompany the boats on all fishing trips and record the results by measuring the sizes of fish retained in the nets.—*G. H. C., April 23, 1936.*

TRAWLER CATCH

Two complete years have elapsed since trawler logs were installed on drag boats operating out of San Francisco. From these logs the Division has obtained daily records of the operation of each set of drag boats showing fishing location of each drag, time and resulting catch, besides other useful information. The fishing location is recorded both as to compass direction and distance from a headland and by the "Fishing Area." These "Fishing Areas," wherein the coastal waters of California are divided into blocks 10 miles square and numbered, were put into use at the same time that trawler logs were installed. Both trawler logs and fishing areas have successfully given much needed and useful information and have opened the way to further expansion of the use of logs on all other large fishing vessels in the state.

The trawler log data are assembled monthly and yearly, by the species' catch in pounds in each fishing area together with the number of boat catches made, on special punch card reports which are summarized on mimeographed trawler reports. Comparison of the trawler report of 1934 with that of 1935 reveals some changes that have occurred in the two years.

In 1934, 11,706,114 pounds of fish were taken by the trawlers operating out of San Francisco in 77 different areas from Oregon to Monterey. The catch was made in 2069 boat days wherein 6906 drags were made. The average catch per boat day was 5658 pounds; average number of drags per day 3.34 and average catch per drag 1696 pounds.

In comparison, the 1935 catch was 12,214,502 pounds in 92 fishing areas with 2111 boat days and 7245 drags. The average catch per boat day was 5786 pounds, the average number of drags per day 3.43 and the average catch per drag 1686 pounds. During 1935 the fishing effort increased somewhat, but the catch per drag remained within 10 pounds of the previous year. Also the percentage of each species of the total poundage taken changed a small amount, for instance in 1934, 84% of all fish taken were flatfish, 52% of which were pointed-nosed sole, and 25% round-nosed sole, while in 1935, 81% of all fish were flatfish, of which 59% were pointed-nosed sole and 20% round-nosed sole. During 1935 Pacific cultus cod increased 1% over the previous year and sable fish jumped up 3%. Changes are apparent also in the catches of the various fishing areas, some of which are quite striking, but their significance will have to wait explanation when data for more years are available.—*G. H. C., April 23, 1936.*

THE PISMO CLAM IN 1935

During the second week of December, 1935, the staff of the California State Fisheries Laboratory made the seventeenth annual Pismo clam census on Pismo Beach. In keeping with the conservation policy of the Division of Fish and Game, all of the clams that could be aged without injury were quickly studied at the laboratory and then replanted on a southern California beach. The plant thus made consisted of 770 clams of this year's set, 6 one-, 50 two-, 7 three-, 25 four-year-olds, and 4 older clams. An exceptionally good set of clams on Pismo Beach this past summer made possible the large plant of young clams on the southern beach.

The 1935 census disclosed an improvement in conditions. This year's set, the best on Pismo Beach, with one exception (1931) since the long famed extraordinary set of 1919, follows closely after four other good sets and makes the conditions on Pismo Beach much more heartening. For many years the future outlook for the clam population was very discouraging. From 1920 to 1928 all forces united against the clams. With the exception of 1924, each year's set was a practical failure. This meant that almost no new clams were added to the population, and at the same time man was taking much too heavy a toll. By 1927 the population had reached its lowest ebb and the situation had become alarming. Man then stepped in and made some amends for his former sins. During the period 1927–1933, several additional stringent laws were enacted and better enforcement measures were provided and have been continued. Beginning with 1929, nature also came to the rescue and five good sets of young clams have occurred in the past seven years, 1929–1935, in contrast to only one fair set in the previous nine years, 1920–1928.

The result of these two forces, better spawning survival and greater protection to immature clams, is the development of a new spawning population on the beach in the intertidal zone. By 1927 clams large enough and old enough to spawn were to be found only in deeper water beyond the low tide line. Now spawning clams are again present in appreciable numbers in the intertidal zone. Many of these are just under legal size, and some legal sized clams are to be found. Many more legal clams would be found were not the demand for Pismo clams so great that the amateur and the commercial digger combine to remove

almost all clams as soon as they reach legal size. This in itself appears to suggest a not too promising situation but other reassuring signs are present. The five good sets in the past seven years indicate that we have a sufficient spawning reserve to produce a good set when and if natural conditions are favorable. A further hopeful sign is the success of the closed area, established in 1929. Here the number of large clams is slowly increasing and these clams are gradually augmenting the spawning population.

The present and future outlook for the Pismo clams on Pismo Beach is therefore more encouraging than it has been for many years. At present there is a good spawning reserve and many clams are just reaching legal size, which means that digging returns will be good for the next two to four years. These clams will be dug out, however, as rapidly as they reach legal size. With the present demand for clams there is unfortunately no way to build up a reserve of legal clams to tide over lean years, which are bound to follow after each poor set of young clams. On the other hand, if present protective measures are not rescinded and if these measures are successfully enforced man may feel a small modicum of pride in his efforts to restore the Pismo clam population and may have some assurance that the restoration is relatively permanent. He must reconcile himself, however, to the fact that always there will be sharp declines and rises in the numbers of legal clams available, each dependent on the failure or success of nature to produce good spawning survival.—*Frances N. Clark and Richard S. Croker, California State Fisheries Laboratory, December, 1935.*

SARDINE FISHING FLEET AT MONTEREY

The following notes are taken from an annual report to the California State Fisheries Laboratory made by J. B. Phillips of the laboratory staff. The report is dated February 20, 1936, and applies to the Monterey sardine fishing season of 1935–36.

Eighty-nine different boats delivered sardines at Monterey and Moss Landing during the 1935–36 season, of which 59 were purse seine boats and 30 were launches with lighters. Twenty of these boats operated less than two full months of the season. All but 3 of the launches were locally owned, but of the 59 purse seiners, 29 were owned by Monterey fishermen and 30 were under "outside" ownership. Fourteen of the 30 purse seiners of "outside" ownership were chartered and captained by Monterey fishermen.

Only 4 of the purse seine boats used ring nets; the others using purse seines, most of which were of tanned rather than tarred webbing. All of the launch and lighter craft used ring nets. The average net used by the purse seine boats (including the 4 ring nets) was 180 fathoms long and 32 fathoms deep. The average size of ring nets used by the launches was 140 fathoms long by 31 fathoms deep or 40 fathoms shorter than the average purse seine.

The average hold capacity of purse seiners was 76 tons as contrasted with an average lighter capacity of 54 tons.—*W. L. S.*

REPORTS

STATEMENT OF REVENUE

For the Period July 1, 1935, to March 31, 1936, of the Eighty-seventh Fiscal Year

Revenue for Fish and Game Preservation Fund:		
Current Year:		
License Sales:		
Angling licenses, 1935	$373,690 50	
Angling licenses, 1936	16,369 00	
Commercial hunting club licenses, 1935-1936	950 00	
Commercial hunting club operators licenses, 1935-1936	215 00	
Deer tags, 1934		
Deer tags, 1935	110,804 00	
Fish breeders' licenses, 1935	25 00	
Fish breeders' licenses, 1936	300 00	
Fish importers' licenses, 1935	10 00	
Fish importers' licenses, 1936	80 00	
Fishing party vessel permit, 1936	85 00	
Fish packers' and wholesale shell fish dealers' licenses, 1935-1936	1,005 00	
Game breeders' licenses, 1935	160 00	
Game breeders' licenses, 1936	890 00	
Hunting licenses, 1934-1935	22,205 00	
Hunting licenses, 1935-1936	200,411 00	
Kelp licenses, 1936	20 00	
Kelp licenses, 1935	10 00	
Market fishermen's licenses, 1935-1936	35,150 00	
Market fishermen's licenses, 1936-1937	840 00	
Trapping licenses, 1935-1936	1,373 00	
Total license sales		$764,592 50
Other income:		
Court fines	$39,585 63	
Fish packers' tax	232,025 98	
Fish tag sales	2,467 66	
Game tag sales	154 11	
Importers' contributions	541 00	
Interest on bank balances	5,744 23	
Kelp tax	142 37	
Lease of kelp beds	1,025 60	
Miscellaneous sales	2,691 10	
Publication sales	520 60	
Salmon Tax, Chap. 1015-35	125 54	
Total other income		$285,032 72
Grand total—Fish and Game Preservation Fund		$1,049,625 22

STATEMENT OF EXPENDITURES

For the Period July 1, 1935, to March 31, 1936, of the Eighty-seventh Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Operating Expenditures—87th Fiscal Year:					
Administration:					
Executive	$3,749 94				$3,749 94
Clerical and office	4,140 00	$1,194 46	$250 99	$105 68	5,691 13
Printing, general		3,943 91			3,943 91
Automobiles		355 62	272 50		628 12
Traveling			3,521 28		3,521 28
Postage			3,689 40		3,689 40
Telephone and telegraph			3,730 38		3,730 38
Freight, cartage and express			710 03		710 03
Rent			9,108 64		9,108 64
Accident and death claims			2,007 80		2,007 80
Accounting pro rata	9,333 38				9,333 38
Legal			2,005 40		2,005 40
Publicity			1,043 61		1,043 61
Federal cooperation	3,065 14				3,065 14
Printing fish and game magazine		2,581 89			2,581 89
Premiums on bonds			35 00		35 00
Pro rata General Fund expense, Chap. 923-33			3,340 93		3,340 93
Total Administration	$20,288 46	$8,075 88	$29,715 96	$105 68	$58,185 98
Bureau of Research and Engineering:					
Clerical and office	$1,753 10		$103 18	$73 70	$1,929 98
Automobiles		$247 54	123 48	898 78	1,269 80
Traveling			3,970 92		3,970 92
Photography			15 61		15 61
Library	1,230 00	146 98	33 50	146 73	1,557 21
Research	3,510 00	62 35	26 53	29 10	3,627 98
Publicity			151 23		151 23
State fair and other exhibits		113 48	1,274 30		1,387 78
Temporary help	416 55				416 55
Telephone and telegraph			127 66		127 66
Freight, cartage and express			246 25		246 25
Rent			104 25		104 25
Heat, light, water and power			209 52		209 52
Laboratory	19,004 67	2,530 70	157 46	2,156 28	23,909 11
Hydro-biological survey, Monterey Bay			750 00		750 00
Cooperative research	1,872 31	895 12	2,936 96	21 04	5,725 43
Statistics	480 00	984 56	1,641 39		3,105 95
Hydraulic engineering	1,800 00	15 61	995 36	14 54	2,825 51
Special field	3,060 00				3,060 00
Terminal Island grounds	275 82	1 37	232 62	6 76	516 57
Total Bureau of Research and Engineering:	$33,462 45	$4,997 71	$13,100 22	$3,346 93	$54,907 31
Bureau of Patrol and Law Enforcement:					
Chief and assistants	$8,325 00				$8,325 00
Clerical and office	3,729 66	$57 36	$27 75	$91 77	3,906 54
Automobiles		23,228 68	8,667 70	19,910 39	51,806 86
Traveling			36,396 97		36,396 97
Postage			564 70		564 70
Telephone and telegraph			1,131 06		1,131 06
Freight, cartage and express			5 72		5 72
Rent			504 19		504 19
Heat, light, water and power			17 43		17 43
Captains and wardens	141,418 70	671 48	580 55	103 00	142,773 73
Launches		1,659 30	1,039 13	398 26	3,096 69
Fish planting	3,432 33	571 06	2,806 15	3 00	6,812 54
Premiums on bonds			332 74		332 74
Commercial fisheries patrol:					
Superintendent	2,070 00				2,070 00
Captains and wardens	9,090 00	11 27	78 53		9,179 80
Launches	9,240 98	3,718 98	2,716 67	269 35	15,945 98
Fish cannery inspectors, seasonal	13,333 03		580 91		13,913 94
Rent			621 92		621 92
Automobiles		338 16	290 83		628 99
Temporary help	73 87				73 87
Total Bureau of Patrol and Law Enforcement	$190,713 57	$30,256 29	$56,393 04	$20,775 77	$298,138 67

STATEMENT OF EXPENDITURES

For the Period July 1, 1935, to March 31, 1936, of the Eighty-seventh Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Bureau of Commercial Fisheries:					
Chief and assistants	$8,483 68		$1,731 32		$10,215 00
Clerical and office	7,200 00	$22 17	37 41	$101 07	7,360 65
Automobiles		422 94	158 81		581 75
Traveling			2,320 81		2,320 81
Telephone and telegraph			361 84		361 84
Freight, cartage and express			10 37		10 37
Heat, light, water and power			61 63		61 63
Fish tags		177 98			177 98
Total Bureau of Commercial Fisheries	$15,683 68	$623 09	$4,682 19	$101 07	$21,090 03
Bureau of Fish Conservation:					
Chief and assistants	$5,445 00				$5,445 00
Clerical and office	3,659 33	$46 28	$10 50	$31 90	3,778 01
Automobiles		5,721 92	2,761 85	1,866 89	10,350 66
Traveling			7,337 94		7,337 94
Postage			155 51		155 51
Telephone and telegraph			853 36		853 36
Freight, cartage and express			472 56		472 56
Rent			2,531 54		2,531 54
Heat, light and power			1,148 98		1,148 98
Hatcheries	$2,428 05	59,826 91	751 82	2,529 57	145,536 35
Fish cars	2,655 00	255 63	2,544 54		5,455 17
Blue printing			43 62		43 62
Cooperative research		80 09			80 09
Temporary help	910 77				910 77
Fish Hatchery assistants—					
Seasonal	18,011 17				18,011 17
Special field	5,310 00	52 88	90	329 21	5,692 99
Fish rescue	1,455 16	587 26	1,680 84	646 51	4,269 77
Total Bureau of Fish Conservation	$119,904 48	$66,570 97	$20,293 08	$5,304 08	$212,073 49
Bureau of Hydraulics:					
Chief and assistants	$1,777 35				$1,777 35
Automobiles		$18 79	$3 50		22 29
Traveling			206 99		206 99
Temporary help	72 59				72 59
Total Bureau of Hydraulics	$1,849 94	$18 79	$210 49		$2,079 22
Bureau of Game Conservation:					
Chief and assistants	$10,494 97				$10,494 97
Clerical and office	2,270 00	$33 44		$236 16	2,539 60
Automobiles		1,757 15	$820 53		2,577 68
Traveling			5,093 34		5,093 34
Postage			2 03		2 03
Telephone and telegraph			245 39		245 39
Freight, cartage and express			18 55		18 55
Heat, light, water and power			1,514 46		1,514 46
Maintenance	9,627 38	7,023 18	246 29	68 18	16,965 03
Temporary help	1,267 25				1,267 25
Quail trapping and expansion of quail program	3,065 00	55 30	23 55		3,143 85
Refuge posting	411 29				411 29
Statistics	610 84	1,031 80	115 96	569 98	2,328 58
Refuge maintenance	4,181 68	1,225 51	2,160 44	8 17	7,575 80
Temporary help, seasonal	2,600 32				2,600 32
Total Bureau of Game Conservation	$34,528 73	$11,126 38	$10,240 54	$882 49	$56,778 14
Bureau of Licenses:					
Clerical and office	$9,469 51	$223 45	$82 22	$200 31	$9,975 49
Printing, licenses and applications		2,036 50			2,036 50
Traveling			510 27		510 27
Postage			1,143 63		1,143 63
Temporary help	$30 32				830 32
Freight, cartage and express			61 57		61 57
Premiums on bonds			1,085 50		1,085 50
Identification license buttons		5,152 47			5,152 47
License commissions			37,862 60		37,862 69
Total Bureau of Licenses	$10,299 83	$7,412 42	$40,745 88	$200 31	$58,658 44
Total eighty-seventh fiscal year expense paid from support appropriations	$426,731 14	$129,081 53	$175,382 28	$30,716 33	$761,011 28

STATEMENT OF EXPENDITURES

For the Period July 1, 1935, to March 31, 1936, of the Eighty-seventh Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Special Items:					
Claim of Chief Accounting Officer of Department of Finance			$1,516 76		$1,516 76
Support of Napa State Farm			6,387 50		6,387 50
Predatory Animal Control:					
Lion hunters	$3,090 67				3,090 67
Predatory animal control		$730 59	4,150 00		4,880 59
Predatory animal hunters and trappers, seasonal	4,700 00				4,700 00
Traveling			646 50		646 50
Total Predatory Animal Control	7,790 67				13,317 76
Total Special Items	$7,790 67	$730 59	$12,700 76		$21,222 02
Total Expenditures for Additions and Betterments:					
Permanent Improvements:					
Construction, improvements and equipment and purchase of game refuges and public shooting grounds, Chap. 341-35	$3,860 86	$7,578 50	$6,326 72	$29,097 78	$46,863 86
Contributions to Employees' Retirement System					11,803 50
Total expenditures, eighty-seventh fiscal year from current biennium					$841,800 66
Prior Biennium Appropriations:					
Eighty-seventh fiscal year:					
Operating expenditures:					
Special Items:					
California Code Commission expenses, Chap. 645-33				$631 92	
Construction Russian River jetties				366 37	
Total Operating Expenditures, eighty-seventh fiscal year					$998 29
Expenditures for additions and betterments:					
Construction, improvements and equipment, Chap. 278-33	$2,078 55	$7,755 46	$1,220 44	$17,277 32	$28,331 77
Eighty-sixth fiscal year:					
Operating expenditures:					
Support				$12,699 46	
Fresh fish marketing				148 79	
Special item:					
License commissions				488 90	
Total operating expenditures, eighty-sixth fiscal year					$13,337 15
Expenditures for additions and betterments:					
Construction, improvements and equipment, Chap. 278-33					$500 00
Eighty-fifth fiscal year:					
Operating expenditures:					
Support				$85 36	
Special item:					
Claim of Chief Accounting Officer of Department of Finance, Chap. 991-33				35 50	
Total operating expenditures, eighty-fifth fiscal year					$49 86
Total prior biennium appropriations					$13,217 07
Grand total proprietory group					$855,017 73

SEIZURES OF FISH AND GAME

January, February, March, 1936

Game:		Fish:	
Deer	12	Abalone	42
Deer feet	6	Abalone slices	4
Deer hides	13	Barracuda, pounds	3,180½
Deer meat, pounds	1,317	Bass, black	17
Doves	10	Bass, rock	1
Ducks	204	Bass, striped	32
Geese	6	Bass, striped, pounds	48
Meadowlarks	9	Catfish, pounds	1,275
Mudhens	8	Clams	2,061
Non-game birds	5	Cockles	1,250
Pheasant	5	Crabs	51
Pigeon	1	Live car	1
Plover	8	Lobsters	101
Quail	111	Mussels, pounds	100
Rabbits	15	Salmon, pounds	1,650
Robins	16	Sunfish	53
Sparrow	1	Trout	161
Squirrels	4	Trout, pounds	241½

FISH CASES

January, February, March, 1936

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalone; closed season; overlimit; undersize	14	$200 00	45
Angling; no license; using another's	24	165 00	40
Barracuda; selling undersize	6	150 00	----------
Bass, black; closed season	3	75 00	----------
Bass, striped; overlimit; undersize; transporting for sale	3	110 00	----------
Catfish; failing to keep dealer's record; keeping undersize in live car	2	10 00	----------
Clams; overlimit; undersize; out of shell; possession in preserve	43	617 50	70
Cockles; overlimit; undersize	3	75 00	----------
Commercial fishing; no license; no reports	33	585 00	20
Crabs; shipping from closed district; undersize	15	105 00	----------
Fish wastage	2	80 00	----------
Gaff hook; use of	7	37 50	----------
Lobsters; undersize	3	35 00	----------
Mussels; taking in refuge	2	----------	20
Net; operating in closed district; illegal size	4	125 00	----------
Night fishing	5	100 00	30
Obstructing stream	1	----------	----------
Pollution	9	400 00	----------
Sardines; illegal use of	1	----------	----------
Seine; possession of and operation in closed district	2	100 00	----------
Set line; use of	2	150 00	----------
Spear; possession of within 300 ft. of stream	5	75 00	10
Spearing	4	25 00	30
Sunfish; closed season	8	105 00	----------
Trout; sale of; fishing with snag outfit; closed season; overlimit	30	455 00	----------
Totals	230	$3,570 00	265

GAME CASES

January, February, March, 1936

Offense	Number arrests	Fines imposed	Jail sentences (days)
Deer; closed season; killing and possession doe	93	$2,830 00	1,332
Dove; closed season; possession wild doves	3	50 00	10
Ducks; closed season; selling wild ducks	25	1,880 00	125
Game birds; trapping; possession of protected	9	49 00	102½
Geese; closed season	1	50 00	
Hunting; no license; making false statement; in game refuge	27	237 00	149½
License; alien using citizen's; failure to show on demand; false statement	5	75 00	
Mammals; taking protected	2	2 00	24
Mudhens; closed season	6	100 00	
Night hunting	4	40 00	
Non-game birds; possession; killing	14	195 00	20
Pheasant; killing and possession; snaring; closed season	8	80 00	260
Pigeons; closed season	6	70 00	12½
Quail; closed season; overlimit; using for bait	12	325 00	60
Rabbits; closed season	10	215 00	
Shooting from automobile and highway	3	85 00	
Spotlight hunting	4	125 00	
Trapping; no license	3	70 00	
Totals	241	$6,478 99	2,101½

FRESH FISH IMPORTATIONS BY POINT OF ORIGIN* FOR JANUARY, FEBRUARY AND MARCH, 1936

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species	Gulf of California	West coast Lower California	International waters south U. S. boundary (definite origin unknown)	Mexican Mainland, Central and South America	Japan	Total pounds
Barracuda		200,148				200,148
Cabrilla	1,517	83,838				85,355
Corbina, Mexican	65,989					65,989
Cultus, Pacific		1,619				1,619
Grouper		35,530				35,530
Halibut, California		256,487				256,487
Mackerel, Pacific		1,669				1,669
Mackerel, Spanish		2,666				2,666
Perch, Salt-water		120				120
Rock Bass		13,449				13,449
Rockfish		50,548				50,548
Sablefish		334				334
Sculpin		625				625
Sea-bass, Black	779	89,832				90,611
Sea-bass, Totuava	933,826					933,826
Sea-bass, White		7,441				7,441
Shark		6,920				6,920
Sheepshead		5,363				5,363
Skate		766				766
Smelt		366				366
Sole		147				147
Tuna, Albacore					647,088	647,088
Tuna, Bluefin		206,681				206,681
Tuna, Bonito		204,614	1,115			205,729
Tuna, Oriental					90,588	90,588
Tuna, Skipjack		213,987	211,051	284,010	547,549	1,257,497
Tuna, Yellowfin		435,506	5,910,781	8,375,620		14,721,907
Whitefish		9,851				9,851
Yellowtail		663,619	45,569			709,188
Crustacean:						
Lobster, Spiny	953	726,699				727,652
Prawn	94					94
Total pounds	1,003,158	3,218,825	6,169,416	8,659,630	1,285,225	20,336,254

* These importations are included in tables of landings. They include fish caught by California boats in foreign waters as well as frozen fish imported for canning in California plants.

FRESH FISH IMPORTATIONS* FROM FOREIGN COUNTRIES FOR JANUARY, FEBRUARY AND MARCH, 1938

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species	Landed in Region 70, Los Angeles	Landed in Region 80, San Diego	Total pounds
Barracuda	173,243	26,905	200,148
Cabrilla	38,941	46,414	85,355
Corbina, Mexican	65,089		65,089
Cultus, Pacific		1,619	1,619
Grouper	8,626	26,904	35,530
Halibut, California	135,847	120,640	256,487
Mackerel, Pacific		1,669	1,669
Mackerel, Spanish	2,666		2,666
Perch, Salt-water		120	120
Rock Bass	2,899	10,550	13,449
Rockfish	3,506	47,042	50,548
Sablefish		334	334
Sculpin		625	625
Sea-bass, Black	58,893	31,718	90,611
Sea-bass, Totuava	921,147	12,679	933,826
Sea-bass, White	5,894	1,547	7,441
Shark	4,652	2,268	6,920
Sheepshead	180	5,183	5,363
Skate	741	25	766
Smelt		366	366
Sole	147		147
Tuna, Albacore	647,088		647,088
Tuna, Bluefin	184,301	22,380	206,681
Tuna, Bonito	11,424	194,305	205,729
Tuna, Oriental	90,588		90,588
Tuna, Skipjack	896,316	361,181	1,257,497
Tuna, Yellowfin	2,253,047	12,468,860	14,721,907
Whitefish	2,764	7,087	9,851
Yellowtail	132,355	576,833	709,188
Crustacean:			
Lobster, Spiny	10,717	716,935	727,652
Prawn	94		94
Total pounds	5,652,065	14,684,189	20,336,254

* These importations are included in the tables of landings. They include fish caught by California boats in foreign waters as well as frozen fish imported for canning in California plants.

CALIFORNIA FRESH FISH LANDINGS* FOR JANUARY, FEBRUARY AND MARCH, 1936

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species	Region 10, Del Norte	Region 20, Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds
Anchovy					580		3,382		3,962
Barracuda						4,110	323,371	84,619	412,100
Cabezone				928	4,024	77			5,029
Cabrilla							38,941	46,414	85,355
Carp			47,495						47,495
Catfish			48,654		2,466				51,120
Corbina, Mexican							65,989		65,989
Cultus, Pacific	2,857	61,061		73,450	28,411		84	1,619	167,482
Eel				15					15
Flounder, Starry		12,254	525	203,097	1,767				218,243
Grouper							8,626	26,904	35,530
Hake				1,931			2,520		4,451
Halibut, California				3,738	31,632	42,421	293,528	156,770	528,089
Halibut, Northern	73	3,995		2,253					6,321
Hardhead			36,346						36,346
Herring, Pacific	34	5,740		740,208	675	89			746,746
Kingfish				735	54,850	314	144,140	322	200,361
Mackerel, Horse					753		92,203	1,845	94,801
Mackerel, Pacific					255,590	6,586	1,567,008	1,632,142	3,462,226
Mackerel, Spanish							2,666		2,666
Mullet								39	39
Perch	292	11,787		31,216	14,436	400	43,715	451	102,297
Pike			204						204
Pompano, California					81		81	15	177
Rock Bass						2,321	18,793	21,472	42,586
Rockfish	7,068	29,553		265,702	533,091	152,377	113,202	85,022	1,186,618
Sablefish		50,294		8,255	65,167	117	62,666	1,939	191,438
Salmon			56,874		18,649				75,523
Sand Dab		271		159,162	4,389		3,925		167,747
Sardine			21,305,195	7,787,701	78,154,681	211	216,177,095	15,531,189	339,556,075
Sculpin							13,624	1,897	15,521
Sea-bass, Black						36	61,873	34,155	96,064
Sea-bass, Short-fin								46	46
Sea-bass, Totuava							921,147	12,679	933,826
Sea-bass, White					342	2,517	63,173	46,232	112,264
Sea Trout	11				41				52
Shad			160,611		11				160,622
Shark				90,571	945	7,683	44,541	15,969	159,709
Sheepshead						9,746	33,030	6,908	49,684
Skate				124,303	12,350	5,602	7,088	6,372	155,715
Smelt		7,811		122,067	14,364	2,943	80,766	2,184	230,735
Sole	101	4,726		2,157,384	52,105	126,785	2,340	21	2,343,462

Split-tail			15,188						15,188
Sucker			30,087						30,087
Tomcod				690					690
Tuna, Albacore							647,088		647,088
Tuna, Bluefin							184,313	22,487	206,800
Tuna, Bonito						178	542,197	751,315	1,293,690
Tuna, Oriental							90,588		90,588
Tuna, Skipjack							896,316	361,181	1,257,497
Tuna, Yellowfin							2,253,173	12,468,873	14,722,046
Turbot				38,323	4,957		19		43,299
Whitebait	32,890	17,220		3,069	761				53,940
Whitefish						3,820	7,563	13,108	24,491
Yellowtail							146,775	580,028	726,803
Miscellaneous fish		3,617	27	36,430	30	289	475		40,868
Crustacean:									
Crab	7,278	54,152		992,368	1,462				1,055,260
Crab, Rock							6,542		6,542
Lobster, Spiny						33,503	38,283	718,936	790,722
Prawn					821		94		915
Shrimp				168,847					168,847
Mollusk:									
Abalone				1,250	100,32 [1]	90,350	75		192,000
Clam, Cockle		177		366			4,475		5,018
Clam, Gaper		1,272		660					1,932
Clam, Jackknife							6		6
Clam, Pismo					6,753	35,805			42,558
Clam, Soft-shell				29,487					29,487
Clam, Washington		10,977		463					11,440
Mussel					300				300
Octopus		384		3,343	16,026		7		19,760
Oyster, Eastern				88,734					88,734
Oyster, Japanese				45,870	2,296				48,166
Oyster, Native				11,623					11,623
Squid				210	52,228		6,286		58,724
Whelk							250		250
Total pounds	50,604	275,291	22,301,206	13,195,649	79,440,962	528,280	225,014,945	32,633,153	373,440,090

[1] Importations of fresh fish from foreign countries included. See importation tables.

31700 8-36 2700

BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol ..... San Francisco

CENTRAL DISTRICT (Headquarters, Sacramento)

S. H. Lyons, Inspector in Charge ..... Sacramento
Jos. H. Sanders, Captain Northern Division ..... Sacramento
S. R. Gilloon, Captain Southern Division ..... Fresno
John O'Connell, Captain ..... Modesto
A. H. Willard, Captain ..... Nevada City
_____, Sergeant ..... Redding

WARDENS (Northern Division)

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W. J. Black ..... Suisun
L. W. Dinsdale ..... Yuba City
C. O. Fisher ..... Susanville
C. L. Gourley ..... Weaverville
Alvin Granstrom ..... Downieville
Brice Hammack ..... Yreka
Earl Hascos ..... Nevada City
A. A. Jordan ..... Alturas
Taylor London ..... Colusa
Charles Love ..... Redding
Leslie Mercer ..... Quincy
Nelson Poole ..... Auburn
Albert Sears ..... Placerville
Chas. Sibeck ..... Sacramento
R. L. Sinkey ..... Woodland
Fred R. Starr ..... Dorris
R. A. Tinnin ..... Challenge
E. C. Vail ..... Willows
H. S. Vary ..... Walnut Grove
Edwin O. Wraith ..... Chico

(Southern Division)

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H. E. Black ..... Madera
Clarence Brown ..... Mariposa
F. A. Bullard ..... Reedley
Ray J. Bullard ..... Porterville
M. S. Clark ..... Merced
Cliff Fontaine ..... Coalinga
Wm. Hentz ..... Lodi
F. F. Johnston ..... Sonora
R. J. Little ..... Jackson
Walter I. Rang ..... Visalia
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Wm. Lipphardt, Captain Southern Division ..... San Francisco
J. D. Borders, Captain ..... Eureka
Harry Lenhart, Captain ..... Santa Rosa
Ralph Classic, Captain ..... Monterey
O. P. Brownlow, Captain ..... Alameda

WARDENS (Northern Division)

W. C. Blewett ..... Crescent City
Earl Caldwell ..... Eureka
Ray Diamond ..... Willits
Scott Feland ..... Fortuna
J. H. Groves ..... Cloverdale
J. W. Harbuck ..... Napa
Ovid Holmes ..... Fort Bragg
E. J. Johnson ..... Lakeport
Wm. F. Kalther ..... Lucerne
Bert Laws ..... San Anselmo
Earl Macklin ..... Ukiah
Leo Mitchell ..... Point Arena
Victor Von Arx ..... Santa Rosa
R. J. Yates ..... San Rafael

(Southern Division)

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C. L. Bundock ..... Oakland
Ed. Clements ..... Martinez
T. K. Duncan ..... Concord
Chas. England ..... San Rafael
E. R. Greenleaf ..... Monterey
Fred W. Hecker ..... San Luis Obispo
C. E. Holladay ..... San Jose
John Hurley ..... Martinez
Mansfield Joy ..... San Francisco
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SOUTHERN DISTRICT (Headquarters, Los Angeles)

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LaRue Chappell, Captain Western Division ..... Los Angeles
E. H. Ober, Captain Eastern Division ..... San Bernardino
L. T. Ward, Captain ..... Escondido
C. H. Groat, Captain ..... Terminal Island
_____ Sergeant ..... Santa Barbara
_____ Sergeant ..... Indio
_____ Sergeant ..... Bishop

SOUTHERN DISTRICT (Western Division)

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R. E. Bedwell	Santa Barbara	W. L. Hare	Wilmington
E. A. Chan	Terminal Island	H. C. Jackson	Santa Ana
A. F. Crocker	Los Angeles	Carmi Savage	Los Angeles
Ray Ellis	Independence	T. W. Schilling	San Diego
Walter Engelke	Terminal Island	C. L. Towers	Los Angeles
E. R. Hyde	Balboa	T. J. Smith	Santa Barbara

(Eastern Division)

J. H. Gyger	Perris	R. C. O'Connor	Banning
Geo. Johnson	Calipatria	W. S. Talbott	Pine Knot
Theo Jolley	Idyllwild	C. J. Walters	Independence
W. C. Malone	San Bernardino	E. L. Walker	Independence

MARINE PATROL

Motor Vessel "Bluefin," Terminal Island
Motor Vessel "Albacore," Monterey
Cruiser "Quinnat III," San Francisco
Cruiser "Broadbill," Newport Beach
Launch "Rainbow," Sacramento
Launch "Hunter," Martinez
Launch "Shrapnel," Lakeport
Launch "Silverside," Eureka

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